

innervation of the forehead. Finally, the operation was so perfected that large series of cases of major trigeminal neuralgia treated by surgical division of the dorsal root were reported (Cushing, Frazier) with a mortality of about 1 per cent. No further notable changes in the technique of the operation were advocated until 1925 when Dandy reported his results following partial section of the root of the trigeminal nerve, approached by way of the posterior cranial fossa and divided close to the pons. In 1929, in a very comprehensive paper on the subject, the results following partial division of the nerve at the pons were described. This reopened the discussion relative to the disposition of the fibers in the root. Frazier had previously expressed the belief that there was a more or less systematic arrangement of the fibers; Van Nouhuys (1930) reported that the fibers were variable in disposition, and Sicard (1932) after a study of forty-two macerated specimens, arrived at the disquieting conclusion that no two specimens examined were exactly alike. Many conflicting reports concerning the clinical results obtained following partial section of the dorsal root are now appearing in the literature. The significance of these cannot be evaluated at the present time. The last contribution concerning the relief of pain in the face is the method of tractotomy of Sjöqvist. The results following this procedure will likewise await further trial.

The interruption (physiological or anatomical) of the conductivity of a facial nerve for spasmodic contraction of the facial muscles has been advocated. As stated, spinofacial and hypoglossofacial anastomosis have been performed for facial paralysis, Ballance (1895); Kennedy (1899); Barrago-Cravella (1901); Beck (1909). Kennedy was the first surgeon to perform an anastomosis between the seventh and eleventh cranial nerves for facial spasm and Gibson probably the first to utilize the twelfth cranial nerve for this purpose. Several surgeons have extended the work; however, no notable contribu-

tions to these procedures have been made within recent years.

According to Dandy, Charcot suggested that since the symptoms of Meniere's syndrome ceased after deafness occurred, surgical section of the nerve would probably alleviate the symptoms. In 1899, Ballance advanced the idea that surgical division of the eighth nerve might relieve the symptoms of Meniere's disease, but the operation was never performed by him. In 1902, Krause proposed a similar procedure for the relief of tinnitus. On October 6, 1908, following a discussion with Charles K. Mills concerning the propriety of dividing the auditory nerve intracranially for the relief of aural vertigo, Frazier sectioned the left eighth nerve in a patient with symptoms that are not in accord with the present-day concept of Meniere's syndrome. Partial relief was obtained. In 1913, Frazier reported the results of a second case in which the left auditory nerve was sectioned intracranially for tinnitus apparently resulting from trauma. There the matter stood until Dandy's report in 1928. Between September, 1924, and January, 1928, nine patients with Meniere's syndrome were operated upon by him. Eight were completely and one partially relieved following total section of the auditory nerve intracranially. In 1933, a second paper by Dandy regarding the surgical treatment of Meniere's syndrome indicated success in thirty cases. McKenzie (1932) reported two cases of intractable vertigo treated by the intracranial division of the vestibular portion of the auditory nerve. The first of these two patients was operated upon in 1931. Relief of symptoms was obtained in both instances. Additional communications of Dandy indicated the use of the subtotal section operation and the employment of this procedure bilaterally with successful results. Recent reports by Adson, Coleman and Munro indicate the general adoption of the idea of section of the auditory nerve for Meniere's disease.

The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.

49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., F.A.C.S., NEW YORK

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NEW SERIES, VOLUME LI

JANUARY TO MARCH

1941

THE AMERICAN JOURNAL OF SURGERY, INC., PUBLISHERS

NEW YORK

MCMXLI

1938, platelets rose to 180,000; hemoglobin, 65 per cent; red blood count, 4,100,000; bleeding time reduced to six minutes; Rumpel-Leede was negative, and clot retraction complete within four hours. Subsequently, a maintenance dose of 3 Gm. of cystine was administered daily and on April 16, 1938, the patient resumed her work as a dancing teacher. Though a complete blood examination was not available, follow-up record on July 15, 1940, disclosed that the patient was enjoying perfect health and is engaged as

test, positive; coagulation time, five minutes; bleeding time, twelve and one-half minutes; iodine number, 55.3; prothrombin time, within normal limits; hemoglobin, 13.5 Gm.; red blood count, 3,700,000; white blood count, 6,000; staff neutrophils, 49; lymphocytes, 44; monocytes, 4. Despite numerous transfusions and other therapy which consisted of snake venom, ascorbic acid, lexitron, ergot, calcium and klotogen, the bleeding from gums and vagina progressively increased in intensity. On April

TABLE II

THE EVALUATION OF INCREASING AMOUNTS OF METHIONINE AS ANTAGONISTS TO THE CYSTEINE CONSTANT WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Normal control Blood 5 cc.	4	Serum ++ Retr. incomp.	Serum ++++ Retr. comp.	Serum ++++ Retr. comp.	
Cysteine 150 mg. Blood 5 cc.	4½	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Methionine 50 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Methionine 100 mg. Cysteine 150 mg. Blood 5 cc.	4½	Serum + Retr. none	Serum ++ Retr. none	Serum ++ Retr. incomp.	Serum +++ Retr. incomp.
Methionine 150 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum ++ Retr. none	Serum +++ Retr. incomp.	Serum ++++ Retr. comp.	
Methionine 200 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum +++ Retr. comp.	Serum ++++ Retr. comp.	Serum ++++ Retr. comp.	

Results: 150 mg. of methionine proved to be the minimum amount which antagonized the antiretractile property of the cysteine constant with restoration of complete clot retraction within three hours.

a ballet dancer, and free of any bleeding tendency.

CASE II. (W. F.) female, age 37, was admitted to Beth-El Hospital March 20, 1939, complaining of bleeding for the past six weeks per vaginum and gums, and "black and blue marks" over various portions of her body. There was no history of having taken drugs or an acute inflammatory condition previous to onset of bleeding. Vaginal examination and menstrual history presented no significant departure from the normal.

Laboratory Data: Platelets, none seen; no clot retraction in twenty-four hours; tourniquet

17, 1939, hemoglobin dropped to 7 Gm.; red blood count, 2,250,000; platelet count, 30,000; moderate anisocytosis, poikilocytosis and achromasia of red blood cells, no material change in white blood count; bone marrow revealed many megakaryocytes. On April 23, 1939, Dr. B. Kogut performed a splenectomy immediately following a transfusion of 500 cc. of blood. Two days postoperatively the hemoglobin rose to 10 Gm.; red blood count, 3,000,000; and platelets, 190,000. On tenth postoperative day: hemoglobin, 10.4 Gm.; red blood count, 3,000,000; platelets, 180,000; clot retraction complete within three and one-half

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use of transfusions and other therapy was eliminated.

CASE III. (L. E.) female, 50 years old, was admitted to Beth Moses Hospital December 20, 1939, complaining of bleeding from nose, and gums and "black and blue marks" over various portions of body for past four weeks. There was a history of occasional nose bleeds and spontaneous ecchymotic areas over the body for the past year. At admission, many ecchymotic areas over thighs, abdomen, back and arms

polynuclear leukocytes, 57; eosinophiles, 6; lymphocytes, 31; monocytes, 6; fragility and prothrombin within normal limits; moderate anisocytosis, poikilocytosis and achromasia of red blood cells; sternal puncture revealed: polynuclear leukocytes, 76; myelocytes, 14; myeloblasts, 3; stem cells, 1.5; eosinophile megakaryocytes, 3.5; eosinophile polymorphonuclears, 2; megakaryocytes, $1\frac{1}{2}$ per 100 white blood cells; nucleated red blood count, $2\frac{1}{2}$ per 100 white blood cells. Bleeding from gums and nose

TABLE IV

THE EVALUATION OF INCREASING AMOUNTS OF GLYCINE AS ANTAGONISTS TO THE CYSTEINE CONSTANT WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Normal control Blood 5 cc.	4	Serum ++ Retr. incomp.	Serum +++ Retr. incomp.	Serum ++++ Retr. comp.	
Cysteine 150 mg. Blood 5 cc.	4	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Glycine 50 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Glycine 100 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum + Retr. none	Serum ++ Retr. incomp.	Serum ++++ Retr. comp.	
Glycine 150 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum + Retr. none	Serum ++ Retr. incomp.	Serum ++++ Retr. comp.	
Glycine 200 mg. Cysteine 150 mg. Blood 5 cc.	4	Serum +++ Retr. incomp.	Serum +++ Retr. incomp.	Serum ++++ Retr. comp.	

Results: 150 mg. of glycine proved to be the minimum amount which antagonized the antiretractile property of the cysteine constant with restoration of complete clot retraction within three hours.

were seen, and there was a continuous sanguinous ooze from gums and nasal bleeding which required packing. There was no history of ingestion of drugs or acute inflammatory condition previous to onset of bleeding. The menopause was present for past three years, and vaginal examination did not reveal any significant departure from the normal.

Laboratory Data: Platelets, 50,000; no clot retraction in twenty-four hours; tourniquet test, positive; coagulation time, five minutes; bleeding time, eleven minutes; iodine number, 53.5; hemoglobin, 92 per cent; red blood count, 4,000,000; white blood count, 6,000;

continued and on January 10, 1940, no platelets were seen on blood examination and clot did not retract in twenty-four hours.

On this date, 10 cc. of venous blood was withdrawn. To 5 cc. of blood, 150 mg. of methionine was added and clot retraction was complete in two hours, whereas the remaining 5 cc. of blood which served as a control did not retract in twenty-four hours. At this time 8 Gm. of cystine in milk was administered daily, and on January 15, 1940, platelets rose to 70,000; clot retraction, one hour and fifteen minutes; and bleeding time was reduced to five minutes. Medication was discontinued until

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monocytes, 8. There was a moderate anisocytosis, poikilocytosis and achromasia of red blood cells. Bone marrow revealed many young megakaryocytes. Despite therapy which included the use of mocassin snake venom, letron and many transfusions, the vaginal bleeding continued and became more profuse, the nasal bleeding, increasingly more frequent and the platelets dropped to 30,000. On March 27, splenectomy was performed by Dr. B. Kogut preceded by massive transfusion. In addition

blasts, 1 per 100 white blood cells; reticulocytes, 4 per cent; bone marrow revealed many megakaryocytes.

Despite the phenomenal rise in platelets immediately following splenectomy, the post-operative course was marked by a succession of most threatening episodes. The vaginal bleeding continued and become increasingly more profuse. On April 2, the fifth postoperative day, signs of fluid in the left chest developed. On April 9, bleeding from gums made its

TABLE VI

THE EFFECTS OF 50 MG. OF METHIONINE, CYSTINE, GLYCINE AND TYROSINE, RESPECTIVELY, UPON 5 CC. OF BLOOD FROM CASE L. E., ESSENTIAL THROMBOCYTOPENIC PURPURA, WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Purpura bld. 5 cc.	3	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none
Purpura bld. 5 cc. Methionine 50 mg.	3	Serum — Retr. none	Serum — Retr. none	Serum + Retr. none	6 hrs. Serum +++ Retr. comp.
Purpura bld. 5 cc. Cystine 50 mg.	3	Serum — Retr. none	Serum — Retr. none	Serum + Retr. none	6 hrs. Serum ++ Retr. comp.
Purpura bld. 5 cc. Glycine 50 mg.	3	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none	12 hrs. Serum +++ Retr. comp.
Purpura bld. 5 cc. Tyrosine 50 mg.	3	Serum — Retr. none	Serum — Retr. none	Serum + Retr. none	24 hrs. Serum + Retr. none

three small accessory spleens, combined weight $13\frac{1}{2}$ Gm., were removed from the gastrosplenic omentum. The platelet count rapidly rose to 150,000 within the next five days and thereafter ranged from 70,000 to 90,000 up to the beginning of May, at which time the platelets decreased markedly in number as was indicated by the following blood examination by Dr. Rosenthal: hemoglobin, 70 per cent; red blood count, 4,240,000; white blood count, 17,700; platelets, 5,000; myelocytes neut., 3 per cent; polynuclear leukocytes, nonsegmented, 8 per cent; polynuclear leukocytes, segmented, 72 per cent; polynuclear basophiles, 1 per cent; lymphocytes, 12; monocytes, 6 per cent; normo-

advent and at times reached threatening proportions. On April 22, the patient experienced severe pain in left hip and thigh and soon after in right thigh. The right lower extremity was definitely weak, and the patient was unable to raise it (hematomyelia). Pain was most excruciating and required morphine for relief. On May 10, 1940, patient complained of dysuria and passed bloody urine for many weeks thereafter. Showers of petechiae and ecchymotic areas appeared from time to time over the body and on the mucous membranes of the mouth and pharynx. On May 18, all these episodes were completely overshadowed by the sudden onset of generalized convulsions which lasted

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by Thomas Eakins (1844-1916)

THE AGNEW CLINIC—1886
Courtesy of the University of Pennsylvania

For explanation see page 40.

The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LI

JANUARY, 1941

NUMBER ONE

Editorials

FIFTIETH BIRTHDAY

THE American Journal of Surgery is fifty years old, having been first published in 1891 in Kansas City, Missouri. At that time it was called the American Journal of Surgery and Gynecology. Fourteen years later the name was changed to its present title. It has had an uninterrupted existence to date. For years it consisted of thirty pages of reading matter. Then, about twenty years ago, it grew into a publication of twelve hundred text pages a year. Ten years later this was doubled, and many special issues have run over three hundred fifty pages of reading matter. Today, the American Journal of Surgery is a fixture in the American surgical scene. It goes to every State in the Union, its Territories and to every civilized country in the world (except at the present time, due to war restrictions).

The contributors to this Birthday Number tell of the birth and growth of the various surgical specialties and surgical societies. Other contributors treat of subjects closely allied with surgery. In this way one gets a good perspective of the progress of surgery in this country during the past half century.

Imagine the state of this country, the profession of medicine, and surgery fifty years ago. Benjamin Harrison was President; the population of the country was 62,622,250; there were 104,805 doctors of

medicine. Electricity for illuminating purposes was still a dream of the future. In cities the well-to-do lighted their houses with gas; others used oil lamps. Highways connecting towns and cities were dirt roads that became well nigh impassable at certain times of the year. There were few hospitals. Only the poor, objects of charity, went to hospitals for surgical operations or medical care. People lived for the most part in houses and not in two and one-half room apartments. When an operation was necessary it was done at the patient's home, the surgeon and his assistants going there with their stew-pots, pans and sterile goods. No self-respecting woman would dream of going to a hospital to give birth to her baby. To be sent to a hospital after serious consultation in the case of obstetrics usually meant a cesarean was in order, an operation with an appalling mortality at that time. Most of the surgical specialties were either in the embryo stage or not thought of. When this Journal was born, Halstead, at Johns Hopkins, had rubber gloves made for his operating-room nurse whom he later married. These gloves were designed to prevent a dermatitis of her hands caused by the technic in vogue at that time. Bloodgood reasoned that if rubber gloves were a comfort to the nurse then why not have the comfort extended to the surgeons and their assistants. All this

is told in J. M. T. Finney's "A Surgeon's Life," a delightful autobiography just published.

In the early nineties certain physicians began to confine their work exclusively to surgery. But their numbers were few. Only a small percentage of medical graduates thought an internship was either necessary or valuable. They jumped from the graduating exercises into practice. But as the century died all this changed. A new era had begun. Hospital construction grew apace and an internship became essential. Some States required a year's internship in order to get a medical degree. Later on, as the specialties became firmly established, the resident system began.

At one time a man could awaken in the morning and without more ado call himself a specialist. Preliminary training was not essential. This, too, has changed. The American College of Surgeons and the various American Boards have done an excellent and praiseworthy work in this connection. The American Medical Association, also, deserves no end of credit for the part it has played in medical education, the standardization of hospitals and their approval of hospitals for intern and resident training.

In 1891, medical schools peppered the land. Many of them were either fly-by-night affairs that sprang up like mushrooms and often as quickly expired, or they were proprietary schools conducted mainly for financial gain. The faculty of such schools judged the success of the school and its teaching by the cash dividends at the end of the year. After Abraham Flexner published his report and recommendations, this type of medical school folded up. Today, the approved Grade A medical schools, rather than making money, require large endowments to keep anywhere near solvent. It has been said that the medical college is the financial nightmare of the university.

In the early nineties the course of instruction leading to a medical degree covered but two years in the majority of schools.

Later it was increased to three years. At the beginning of the present century the standard four year course began and some schools increased it to five years. Fifty years ago it was not unusual for a mere lad, not yet twenty-one years of age, to graduate from medical school. In the majority of states he could not receive his degree until he had complied with the law. We have a close friend, just reached the retiring age of sixty-five years, who had to wait a year before receiving his degree because when he was graduated he was just twenty years old. At the present time it may be that the pendulum has swung as far to the other side; for now by the time a student has completed his academic and medical education, served an internship and residency, and done some extra post-graduate work, he has reached his middle years.

Out of curiosity we went to a library and managed to get hold of some eastern medical school catalogues of the beginning nineties. We were curious to see what textbooks were recommended and required.

We learned that Flint had written three books: Practice of Medicine (\$4.00), Clinical Medicine (\$3.60) and Percussion and Auscultation (\$11.40). Surgery was represented by such authors as Erichsen (\$7.00), Bryant (\$5.20) and Billroth (\$4.00). Diseases of the Genitourinary System, by Keyes (\$4.00), was popular, as was his Venereal Diseases. Sayre wrote Spinal Diseases and Spinal Curvature (\$3.20). Lusk's Obstetrics (\$4.00) was universally popular, while Gray's Anatomy (\$4.80) competed with Quain's Anatomy which cost \$9.60. Some of the other titles were: Diseases of Women, by Skene; Diseases of the Skin, by Tilbury Fox; Gould's or Quain's Medical Dictionary; Shepard's Chemistry; Klein's Elements of Histology; Huxley's Elementary Physiology or Foster's Physiology; H. C. Wood's Therapeutics and Materia Medica; Mann's Prescription Writing (most schools do not teach this subject today); Hamilton's Fractures and Dislocations and Delafield

AMERICAN JOURNAL
OF
SURGERY
—AND—
GYNÆCOLOGY

Edited and Published by
EMORY LANPHEAR, M. A., M. D., PH. D
1209 Grand Avenue,

KANSAS CITY, Mo.

Vol. I

JULY 1891

No. I

PRICE, ONE DOLLAR PER ANNUM,
Payable at End of Year if Preferred.
PUBLISHED MONTHLY.

W. P. CLEARY,
P. O. Box 1790, New York City,
GENERAL AGENT.

Advertising Rates Made Known on Application.

and Prudden's Pathological Anatomy. One catalogue stated that "Text-books may be obtained from the janitor, at the College."

There have been three editors of the American Journal of Surgery since it was founded. The first editor was Emery



EMORY LANPHEAR, M.D., PH.D.

Editor of The American Journal of Surgery, 1891-1905.

Many of the former textbooks were the bane of medical students. Huge tomes had to be carried about and great volumes had to be digested.

And so, during these long ago but peaceful times, away out in the then far west, Kansas City, The American Journal of Surgery was born. It was published monthly and the subscription price was "One dollar per annum—*Payable at the end of the year if preferred.*" Evidently, many took advantage of this generous offer but forgot to part with the dollar when due, for, somewhat later the subscription rate became fifty cents but that was "*payable strictly in advance.*" This price held for all "citizens of the United States outside of Kansas." For some unaccountable reason foreigners and the Kansans were charged one dollar. About 1893, the circulation had increased to 5,000 (we wonder how much of this was dead wood and unpaid) and the subscription rate went back to one dollar. In Volume V, the reader's attention was called to the fact that it was a "clean, bright, newsy paper full of interesting news and medical literature." In 1898, it became a weekly for a short time.



WALTER M. BRICKNER, M.D.

Editor of The American Journal of Surgery, 1905-1928.

Lanphear, M.A., M.D., PH.D., LL.D. He served from 1891 to 1905 when he was succeeded by Walter M. Brickner, M.D., who carried on until 1928 when the present editor took over.

Both Dr. Lanphear and Dr. Brickner were interesting personalities and men of parts. Lanphear was born in 1859 and received his medical degree at Missouri Medical College, St. Louis, in 1881. He did a good deal of postgraduate work in Chicago and New York. He was Professor of Operative Surgery, Kansas City Medical College, Professor of Surgery, St. Louis College of Physicians and Surgeons, and Professor of Surgical Gynecology and Clinical Surgery, Medical Department, National University of Arts and Sciences, St. Louis. These chairs he held at various times. He was president of the St. Louis Academy of Medicine, and also of the Tri-State Medical Society of Iowa, Illinois and Missouri. So, he must have been quite a doctor. He died

at the age of sixty on February 6, 1920, at Citrus Park, Florida.

In 1905, the ownership of the Journal changed hands. It came to New York and Walter M. Brickner became editor. On the occasion of the change in ownership and editorship Dr. Lanphear published the following "Valedictory" in the April, 1905, issue:

"If it be true that 'of two evils one should choose the less' certainly of two good things one should select the better. American Journal of Surgery and Gynecology has grown to such a remarkable degree that one man no longer can manage it. I have therefore submitted to the inevitable and resigned the editorship in order to devote my entire attention to my private practice. The Journal is removed to New York and placed under the management of Dr. Jos. MacDonald, Jr., who is well and favorably known to every surgeon and gynecologist of America by reason of his many years' success as a medical publisher. The editorship passes to Dr. Walter M. Brickner who has had much experience in that field of work. So—it may be predicted safely that the Journal is sure to be of greater value and importance under the new management than it has ever been under the old. To the many friends who for nearly twenty years have assisted me in making American Journal of Surgery and Gynecology one of the leading medical periodicals of the world I wish to express my sincere thanks; also earnestly to request them to aid the new management with the same encouragement and support they have so heartily given to me. To the thousands of readers in every part of the land I extend my hand in a most cordial Farewell!"

We republish this valedictory because the change marked another milestone in the life of the Journal. Under Dr. Brickner's guidance it became a new and different publication.

Dr. Walter Brickner was an unusual man. He was editor from 1905 until 1928. It was a great loss when he died in 1930, on which

occasion Dr. Howard Lilienthal wrote in an editorial in the August, 1930, issue, in part as follows:

"A handsome, slender, bright-eyed youth, Walter Brickner appeared before the Examining Committee at Mount Sinai Hospital competing for a place on the House Staff. It was then that I first met him. I was assisting Dr. A. G. Gerster, Examiner in Surgery.

"The Phi Beta Kappa symbol gave promise of scholarship and brilliancy which was confirmed as soon as he began to speak. He easily won the honors of the examination. . . .

"With the skill and originality which brought success in Surgery, a fine technical quality set his writing at a high level and distinguished the character of his contributions to the literature. Especially in his work on the treatment of actinomycosis of the pelvic recesses and in his articles on subacromial bursitis there was a clearness of thought and expression which made reading easy and which forcefully carried his message. What more natural then that with such talent he should be attracted to the field of medical journalism and that finally he should achieve a prominent editorial position. For many years, under his management, the American Journal of Surgery developed and became more and more attractive to important contributors both here and abroad.

"The World War reached out and at last drew our country into its grip. To Captain Brickner, later Lieutenant Colonel, was given the responsibility of assembling the group of men who became the enlisted personnel of Base Hospital No. 3, also known as the Mount Sinai Hospital Unit. . . .

"Overseas Dr. Brickner, then a Major, rendered valuable and patriotic service both at the Base and in Evacuation Hospital No. 8 near the front. Through it all his exquisite humor never failed while his personal care and tender sympathy gave last comfort to those whom his skill could not save.

"Back from the War Colonel Brickner, now once more a New York Surgeon, became active in military organizations and, for a time was Surgeon on the Staff of the Manhattan Chapter of the Military Order of the World War.

"He resumed his position at Mount Sinai Hospital and later became Chief Surgeon of the Hospital for Joint Diseases. Dr. Brickner was also honored by an appointment as Skeletal Surgeon to Morristown Hospital.

"He was a Fellow of the New York Surgical Society and of the Academy of Medicine and was associated with other professional bodies.

"And now, at the height of his career, he is gone! All those who knew him grieve over the loss of a faithful friend and comrade while our profession will sorely miss an outstanding figure."

Dr. Brickner did an excellent piece of work and laid a firm foundation for future growth.

We took over the editorship in 1928. Then, we had a lot of ideas but only sufficient material for about one issue. For a long time it kept us awake nights wondering how we could get suitable material to meet the oncoming dead-line. Now, we keep awake for exactly the opposite reason—to keep from accepting too much material. However, we have no wish to recite all that has been done and the changes made in a little over a decade. Suffice it to name a few: The Journal was increased to 2,400 text pages a year. Changes were made in the advertising policy and the advertising curve has gone steadily upward during the past five years. Three textbooks were published serially. Then, monographs were introduced, complete in one issue. Special Numbers, most of them under a Guest Editor, appeared three or four times a year. Our friends have informed us that the monograph and special-number ideas have been copied by other publications. If this be true, we are flattered.

We have been asked on what basis we accept an article. Perhaps it is an editorial sixth sense. But if an article has a good

practical point in diagnosis, treatment or technic, we believe it worthy of publication. Above all we want the Journal to be a helpful journal, a practical journal in that it will aid the man from the big surgical centers as well as the individual doing all the surgery in a small town. We favor papers short and to-the-point, and we judge the material on its merits and not on the name under the title. Evidently, this has been a good policy for the circulation has had a persistent, healthy growth. Many subscribers have been with us for many years. For instance, Dr. J. B. Lowman, of Johnstown, Pennsylvania, has been a subscriber for forty years.

During the past fifty years articles by nearly every surgeon of national reputation have appeared in our pages. Sometimes their articles have been "firsts." Our Associate Editorial Board are not just window dressers. We use them and often. We seek their counsel and advice. In the main, we send them articles that come to us for publication. We ask them to pass judgment on the worth and value of these articles, and we accept or reject an article upon the report received. We have yet to ask a favor of any member of our Editorial Board in vain. Their spirit and co-operation have been splendid.

Today, The American Journal of Surgery is a fixture, a part of American surgery. One day another editor will take our place; it may have other publishers, but it will never have one more generous and progressive than the present one; and we wonder what America, medical education, the practice of surgery and this Journal will be like when another fifty years have ended. We pray the world will be at peace, that men will truly be civilized, that medicine will be a profession of men known as good citizens and possessed of high ideals and dignity, and that what has been planted during times of travail will have flowered into something fine and permanent, and that our grandchildren and great-grandchildren will know the true meaning of contentment, freedom and peace on earth.

T. S. W.

A HALF CENTURY OF SURGICAL LITERATURE

EVENTS lived day by day are little impressive; it is like growing a wart.

It is only when reviewed in retrospect that they become impressive. The books of the early days were individual efforts. Gross and Agnew were and are still monuments to their authors. Gross, who wrote the first books on pathology in the English language reflected this knowledge through his books on surgery. Agnew was the master clinician who it seemed had seen everything, of course everything that had been recognized within his day.

Systems by many authors were an invention of a later day. The editor selects a group of his colleagues who are assigned to discuss a given subject. The handicap lies in the fact that being nominated by his friend for a given task he accepts the assignment. Having no primary interest in writing, it is poorly done. He is in the position of a deacon when called on by the minister to lead in prayer. Being in profound thought of a horse trade he expects to put over the next day, he is startled and the prayer is apt to be sketchy and unconvincing because he is attempting to carry on two lines of thought at once.

Much more salutary are the many monographs written by one author. It is a subject in which he has a special interest and consequently receives his best efforts. These monographs usually contain all that is known about a subject, and then some, trusting the reader to locate what is likely to be useful to him. Recently a number of brief exceedingly practical books have appeared which tell the reader what he should know.

The notable advance in literature has taken place in the periodic literature. The Journal of the American Medical Association was once an anemic little sheet not the equal of many of our state journals. It is

today the leading periodical in any language. It contains articles read at the national meetings, the news of the doings, in the various stages, why people are sued for malpractice and last but not least, each subscriber is sure to get his name in the journal some day—a complete necrology is given each week.

As a reaction a number of the worth while weeklies of long ago have been suspended. This was inevitable but unfortunate because many of the best articles were published in these journals and book files of them furnish many of our best references.

Among surgical journals the Annals remains with us, dignified as ever, containing only articles of high class, and for the most part practical. Notable addition to the Journal list is the Archives, a protege of the American Medical Association. The articles are primarily scientific and of primary interest to those engaged in research. Also notable is Surgery, Gynecology and Obstetrics, which is characterized by articles of worth. Noteworthy is the abstract department. This covers most of the worth while articles published in journals throughout the world.

Last but not least is the American Journal of Surgery. This is an eminently practical journal containing articles useful to every practicing surgeon, the friend in time of need. The articles are brief, to the point, and valuable to the practicing surgeon. It should be noted, too, that the American Journal of Surgery comes out in a new dress with this issue. Its cover is new and so also the general format. The type used for department headings has been changed to conform with that used on the cover and to make the Journal as attractive as possible.

ARTHUR E. HERTZLER





THURSTON SCOTT WELTON, M.D., F.A.C.S.
Editor, The American Journal of Surgery, 1928-

Our Editor

THURSTON SCOTT WELTON, M.D., F.A.C.S., Brooklyn, New York, is the Editor of The American Journal of Surgery, a post which he has held since 1928. He is also professor of clinical obstetrics and gynecology, Long Island College of Medicine, director of the Department of Obstetrics and Gynecology, Greenpoint Hospital, attending obstetrician and gynecologist to Long Island College Hospital and consulting gynecologist to Southside Hospital. In 1917, he held the office of president of the Brooklyn Medical Society, in 1926 he was the president of the Brooklyn Gynecological Society and in 1927 was elected president of the Medical Society of the County of Kings. He is a Fellow of the American College of Surgeons and of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons. Since 1930, Dr. Welton has been a Diplomate of the American Board of Obstetrics and Gynecology.

Associate Editors



Fernand de Gueldre

CARL BECK

CARL BECK, M.D., F.A.C.S., Chicago, Illinois, was born in Nilin, Bohemia, in 1864. He attended the Royal Gymnasium of Prag and was graduated from the Medical Faculty of Prag in 1889 after which he came to America. From 1891 to 1917, he was professor of surgery and surgical pathology at the College of Physicians and Surgeons, Illinois State University. He is one of the charter members and founders of the American College of Surgeons, an honorary member of the Academy of Rome, Italy, and a member of the Gesellschaft der Ärzte, in Vienna. Dr. Beck was the founder of two hospitals in Chicago, North Chicago and St. Anthony Hospitals, and was influential in the establishment of the system of exchange professors between the United States and Europe. In 1912, he was asked by the Nobel Committee to recommend a candidate for the Nobel Prize. Dr. Alexis Carrel, Dr. Beck's former assistant, was chosen. Dr. Beck has educated large numbers of assistants, several of whom now occupy important posts at different universities.



Clifford Norton

CLAUDE S. BECK

CLAUDE SCHAEFFER BECK, M.D., F.A.C.S., Cleveland, Ohio, received his degree in medicine at Johns Hopkins University in 1921. In 1923, he was the Arthur Tracy Cabot Research Fellow at Harvard Medical School and in 1924 the Crile Research Fellow at Western Reserve University. Since 1924 until today he has held the posts of assistant resident, resident, instructor, assistant professor and associate professor of surgery at Western Reserve University. Dr. Beck has carried out extensive studies for the development of cardiac surgery. He has introduced the concept of the compressed heart; he has demonstrated the extrinsic factors that cripple the heart, and he introduced the operation for revascularizing the heart by grafting tissues upon the heart. Dr. Beck was the first person to defibrillate the human ventricles. He has shown that cardiac contusion is not an uncommon injury to the heart, and has suggested reinforcement of the cardiac wall against rupture by placing grafts of pericardium upon the weakened wall of the heart.



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GEORGE R. BRIGHTON

GEORGE RENFREW BRIGHTON, M.D., F.A.C.S., New York, New York, was born in Jersey City, New Jersey, in 1900. He is a graduate of Dwight Preparatory School and his degree in medicine was secured at the College of Physicians and Surgeons, Columbia University, in 1924. Dr. Brighton also studied at surgical clinics in Great Britain and on the continent. He served a surgical internship at Roosevelt Hospital and an ear, nose and throat internship at Bellevue Hospital. In 1925, he took a special course in peroral endoscopy under Dr. Chevalier Jackson. He is a Fellow of the New York Academy of Medicine, of the American College of Surgeons and of the American Academy of Ophthalmology and Otolaryngology. He is also a Diplomate of the American Board of Otolaryngology. He is now attending otolaryngologist to Presbyterian Hospital, Vanderbilt Clinic and Babies Hospital, consulting otolaryngologist to Roosevelt Hospital and assistant clinical professor of otolaryngology at the College of Physicians and Surgeons, Columbia University.

MEREDITH FAIRFAX CAMPBELL, M.D., F.A.C.S., New York, New York, was born at Lake Geneva, Wisconsin. He received his medical degree at Columbia University in 1919 and now specializes in urology. He is a Diplomat of the American Board of Urology, a member of the American College of Surgeons and of a number of well known medical and surgical organizations. In 1930, Dr. Campbell was chairman of the Section on Genito-Urinary Surgery of the New York Academy of Medicine; in 1930, he was vice-chairman of the Section on Urology of the American Medical Association. At present he is president of the American Urological Association and treasurer of the Society of the Alumni of Bellevue Hospital. Dr. Campbell is also professor of urology, New York University, associate visiting urologist to Bellevue Hospital, director of urology at Mountainside Hospital, Montclair, New Jersey, and consulting urologist to Memorial Hospital, Morristown, New Jersey. Dr. Campbell is the author of "Infection of the Kidney" and of "Pédiatrie Urology."

*Underwood & Underwood*

MEREDITH F. CAMPBELL

JAMES THOMAS CASE, M.D., F.A.C.S., Chicago, Illinois, was born in San Antonio, Texas, in 1882. He was graduated from the American Medical Missionary College which later merged with the University of Illinois College of Medicine. He received his Diploma of Medical Radiology and Electrology at Cambridge University, England, in 1920. At various times he was president of the American Roentgen Ray Society, American Radium Society and the American College of Radiology. During the World War he acted as Head of the X-ray Service of the American Expeditionary Forces. At present he is professor of roentgenology, Northwestern University Medical School, radiologist to Passavant, Highland Park and U.S. Marine Hospitals and on the surgical staffs of Grant and Swedish Covenant Hospitals. He is also consultant in radiology to Cook County Hospital. Dr. Case has always been interested in the correlation of surgical and radiological work, and has been interested especially in digestive disorders and in the treatment of cancer. He was the first in the United States to employ 200 kilovolt deep x-ray therapy.



JAMES T. CASE

ISIDORE COHN, M.D., F.A.C.S., New Orleans, Louisiana, specializes in surgery. He received his academic degree at Louisiana State University in 1903 and his degree in medicine from Tulane School of Medicine in 1907. He served on the faculty of Tulane University from 1909 to 1937 occupying the positions of clinical assistant, instructor in minor surgery and professor of clinical surgery in the Undergraduate School, and professor of surgery and director of the Department of Surgery in the Graduate School of Medicine. At the present time he is the professor of surgery and associate director of the Department of Surgery of the Graduate School of Medicine, Louisiana State University Medical Center. In 1935, Dr. Cohn was elected Chief of the Surgical Staff of Touro Infirmary to succeed Dr. Rudolph Matas who retired. He now acts as senior visiting surgeon to Charity hospital, senior consultant in surgery to Flint-Goodridge Hospital and director of medical service at the Episcopal Home.



ISIDORE COHN



BRADLEY L. COLEY

BRADLEY LANCASTER COLEY, M.D., F.A.C.S., New York, New York, was graduated from Yale in 1915 and from the College of Physicians and Surgeons, Columbia University, in 1919. In 1925, Dr. Coley was president of the New York and New England Association of Railway Surgeons and in 1938 was secretary to the New York Surgical Society. At one time Dr. Coley was chosen as a member of the Commission for the Study of Crippled Children. He is also one of the founders of the American Board of Surgery and a Fellow of the American Surgical Association, American College of Surgeons, Southern Surgical Association, New York Surgical Society and Eastern Surgical Society. At present he is chief surgeon of the New York Central Railroad, attending surgeon to Memorial Hospital and the Hospital for Ruptured and Crippled, visiting surgeon to Lincoln Hospital and surgeon-in-chief to Mary McClellan Hospital, Cambridge, New York. Dr. Coley is the author of many monographs on hernia, bone tumors and other surgical subjects.

*Kazanlian*

FREDERICK A. COLLER

FREDERICK AMASA COLLER, M.D., F.A.C.S., Ann Arbor, Michigan, was born in Brookings, South Dakota, in 1887. He received his academic degree at South Dakota State College in 1906 and was graduated from Harvard Medical School in 1912. During 1915 and 1916 he served with the Royal Army Medical Corps of the British Expeditionary Forces and from 1917 to 1919 was with the American Expeditionary Forces. His rank at the end of the war was that of Lieutenant Colonel. At present Dr. Coller is engaged in the practice of general surgery and is professor of surgery and chairman of the Department of Surgery at the University of Michigan and University Hospital.



PAUL C. COLONNA

PAUL C. COLONNA, M.D., F.A.C.S., Oklahoma City, Oklahoma, was born in Norfolk, Virginia, in 1892. He received his degree in medicine at Johns Hopkins Medical School. Dr. Colonna served general surgical internships at St. Elizabeth's Hospital, Richmond, Virginia, and at Memorial Hospital, New York City. He was associate orthopedic surgeon and chief of clinic to the Hospital for the Ruptured and Crippled, New York, from 1930 to 1937, and for one year was the assistant professor of clinical orthopedic surgery at the College of Physicians and Surgeons, Columbia University. At present he is professor of orthopedic surgery, University of Oklahoma School of Medicine, and director of the Department of Orthopedic Surgery at State University and Crippled Children's Hospital. Dr. Colonna is a member of a number of orthopedic associations and medical societies and is the author of numerous articles on orthopedic surgery, with particular reference to ununited fractures of the neck of the femur and congenital dislocation of the hip.

GEORGE CRILE, M.D., F.A.C.S., Cleveland, Ohio, received his medical degree from Wooster University (now known as Western Reserve University) in 1888. He also studied in Vienna, London and Paris. Dr. Crile was the president of the American College of Surgeons in 1916 and chairman of the Board of Regents of that organization from 1917 to 1939. He is also one of the founders and directors of the Cleveland Clinic Foundation. At present he is surgeon to the Cleveland Clinic Hospital.



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GEORGE CRILE

ELLIOTT CARR CUTLER, M.D., F.A.C.S., Boston, Massachusetts, is a graduate of Harvard University and Harvard Medical School. He also holds an honorary doctorate from the University of Strasbourg. Dr. Cutler held the following posts at various times: Surgical house officer, Peter Bent Brigham Hospital; resident surgeon, Massachusetts General Hospital; alumni assistant in surgery, Harvard Medical School; voluntary assistant at Rockefeller Institute; instructor in surgery at Harvard; associate in surgery, Peter Bent Brigham Hospital; professor of surgery, Western Reserve University School of Medicine, and director of the surgical service, Lakeside Hospital, Cleveland. During the World War he held the various ranks of Lieutenant, Captain, Major and Lieutenant Colonel and was decorated with the Distinguished Service Medal. At present he is consulting surgeon to New England Peabody Home for Crippled Children, Moseley Professor of Surgery, Harvard Medical School and surgeon-in-chief to Peter Bent Brigham Hospital. His hobbies are fishing, old medical books, golf, tennis and the collecting of stamps.



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ELLIOTT C. CUTLER

CHARLES ALBERT ELSBERG, M.D., F.A.C.S., New York, New York, is a graduate of the College of Physicians and Surgeons, Columbia University. He was at one time honorary consultant to the Police Department of New York City, contract surgeon to the New York Neurosurgical School and to the United States Army General Hospital No. 1. Formerly he was president of the American Neurological Association and of the Association for Research in Nervous and Mental Disease. Dr. Elsberg, who specializes in neurosurgery, is at present Professor Emeritus of Neurosurgery at the College of Physicians and Surgeons, Columbia University, Surgeon-In-Chief Emeritus to the Neurological Institute and consulting surgeon to Mount Sinai, Knickerbocker, Manhattan State and Ward's Island Hospitals, in New York City, and Vassar Brothers Hospital in Poughkeepsie, New York.



CHARLES A. ELSBERG



HERBERT C. FETT

HERBERT C. FETT, M.D., F.A.C.S., Brooklyn, New York, was graduated from Long Island College of Medicine in 1913. He is now orthopedic surgeon to Long Island College, St. Mary's, St. Peter's, Holy Family and St. Charles (Port Jefferson) Hospitals, consulting orthopedic surgeon to South Side (Bay Shore) and Huntington Hospitals and director of the Fracture Service, Greenpoint Hospital. Dr. Fett is clinical professor of orthopedic surgery at Long Island College of Medicine and a Fellow of the American Board of Orthopaedic Surgery.



C. R. G. FORRESTER

C. R. G. FORRESTER, M.D., F.A.C.S., Chicago, Illinois, was born in Houghton, Michigan, in 1880. He attended college in Toronto, Canada, was graduated from the Medical Department of Loyola University, and did postgraduate work in Vienna, Austria. During the World War he served in the Alder Hey Military Hospital. He is now on the staffs of the Chicago Memorial, Edgewater and St. Joseph's Hospitals, and is a member of the Institute of Traumatic Surgery and of the Chicago Medical Society. Dr. Forrester is the author of "Imperative Traumatic Surgery" and of numerous surgical articles. He is now occupied in consultation practice on bone and peripheral nerve surgery.



H. DAWSON FURNISS

HENRY DAWSON FURNISS, M.D., F.A.C.S., LL.D., New York, was born in Selma, Alabama, in 1878. He attended the University of Alabama and was graduated from the University of Virginia in 1899. During the war he was a Captain of the United States Army. Dr. Furniss did postgraduate work in Berlin from 1901 to 1902. At one time he served as professor of gynecology, New York Post-Graduate Hospital, and is now clinical professor of surgery at New York University Medical College. He is also consulting gynecologist to New York Post-Graduate Hospital and to a number of institutions in New Jersey. At the New York Infirmary for Women and Children he is the consulting cystoscopist and is surgeon to Flower-Fifth Avenue Hospital. He has made a goodly number of contributions to medical literature and has invented several useful surgical instruments.

JOHN HEYSHAM GIBBON, M.D., Media, Pennsylvania, was born at Charlotte, North Carolina. He received his preparatory education at the Macon School and his medical degree from Jefferson Medical College, Philadelphia. From 1907 to 1931 he was professor of surgery and clinical surgery at Jefferson Medical College. During the Spanish American War he was surgeon to the U. S. Vol. Engrs. and was Colonel and consultant in surgery with the A.E.F. during the World War. Following his return from France in 1919, a number of papers appeared on his experience gained during the war in the treatment of wounds and infections. He has been a devoted teacher of the art and practice of surgery and his didactic lectures were always models of clarity and precision. Consequently, note taking was easy and inattention rare during the lecture hour. Dr. Gibbon now lives on his farm where, since his retirement from active surgery, he has devoted himself to extremely skillful and enthusiastic performance in carpentry, wood-carving and cabinet making.



W. Coulbourn Brown
JOHN H. GIBBON

EMIL GOETSCH, M.D., PH.D., Brooklyn, New York, was born in Davenport, Iowa. He received his academic degree at the University of Chicago and his degree in medicine from Johns Hopkins University Medical School. He was formerly president of the American Association for the Study of Internal Secretions and associate professor of surgery at Johns Hopkins Medical School. He is one of the founders of the American Board of Surgery and an honorary member of the Royal Surgical Society of Rome. At present he is active as professor of surgery, Long Island College of Medicine, and surgeon-in-chief to Long Island College Hospital. Dr. Goetsch's specialty is thyroid surgery.



Underwood & Underwood
EMIL GOETSCH

CHARLES ALBERT GORDON, M.D., F.A.C.S., Brooklyn, New York, was born in 1883. He was graduated from Cornell University Medical College in 1905 and now specializes in gynecology and obstetrics. At one time he served as chairman of the Committee on Maternal Welfare, Medical Society of the County of Kings and of the Medical Society of the State of New York, and is the ex-president of the Medical Society of the County of Kings and of Brooklyn Gynecological Society. He is now professor of obstetrics and gynecology and the director of obstetrics and gynecology, Long Island College of Medicine; attending gynecologist and obstetrician to St. Catherine's Hospital and consulting gynecologist and obstetrician to Greenpoint and Beth-El Hospitals. He also holds numerous other gynecological and obstetrical posts.



CHARLES A. GORDON



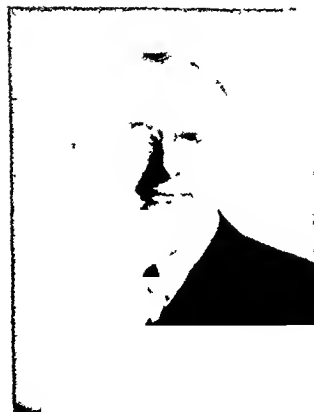
DONALD GUTHRIE

DONALD GUTHRIE, M.D., F.A.C.S., Sayre, Pennsylvania, was born at Wilkes-Barre in 1880. He received his bachelor's degree at Yale, his degree of medicine at the University of Pennsylvania School of Medicine, and an honorary degree of doctor of science from Lafayette College. He is an ex-president of the Pennsylvania Medical Society, one of the thirteen organizers of the American Board of Surgery and is a member of the Board of Governors of the American College of Surgeons. In 1938, he was associate professor of surgery at the Graduate School of Medicine, University of Pennsylvania, and since 1910 has been surgeon on the staff of the Guthrie Clinic and Robert Packer Hospital.



ARTHUR E. HERTZLER

AARTHUR E. HERTZLER, M.D., F.A.C.S., Halstead, Kansas, was born at West Point, Iowa, on July 26, 1870. He was graduated from Northwestern University in 1894 and attended the University of Berlin from 1899 to 1901. Dr. Hertzler is now connected with Halstead Hospital but formerly was on the staffs of St. Luke's, St. Mary's and Kansas City General Hospitals. Dr. Hertzler's practice is confined to skin disorders and he states that he has been "accused" of being a surgeon. His only claim to distinction is that he has never held an office and has never been threatened with one. He asserts that his routine has been just plain hard work seven days a week and that he has always been too tired to take a vacation. He is the author of the well known and widely read "Horse and Buggy Doctor," a delightful work published by Harper and Brothers.



LOUIS J. HIRSCHMAN

LOUIS J. HIRSCHMAN, M.D., F.A.C.S., Detroit, Michigan, was born in Republic, Michigan, in 1878. Dr. Hirschman, who is a proctologist, specializes in surgery of the anus, rectum and colon. He received his degree in medicine at Detroit College of Medicine in 1899. He is one of the founder members of the American College of Surgery and during the World War was a Major in the Medical Corps of the American Expeditionary Forces at Base Hospital No. 17. He is now the president of the American Board of Proctology and is proctologist and head of the Department of Proctology at Harper, Women's and Charles Godwin Jennings Hospitals, and consulting proctologist to Detroit Receiving Hospital, Evangelical Deaconess, St. Joseph's Mercy and U. S. Marine Hospitals. In addition Dr. Hirschman is the extramural lecturer in postgraduate medicine at the University of Michigan. He has written "Handbook of Diseases of the Rectum," "Synopsis of Ano-Rectal Diseases," and is the co-author of the Year Book of Anesthesia published 1915 to 1918. He is also on the editorial boards of The Review of Gastroenterology and the American Journal of Digestive Diseases.

FREDERICK CLARK HOLDEN, M.D., F.A.C.S., New York, New York, is a specialist in obstetrics and gynecology. He was graduated from New York University in 1892 and served an internship at St. Mary's Hospital, Brooklyn, for one year. He was an assistant attending surgeon to St. Mary's Hospital, assistant attending gynecologist to Williamsburg Hospital and assistant attending obstetrician and gynecologist to Long Island College Hospital. From 1919 to 1934 he was connected with Bellevue Hospital, first, as director of the Gynecological Service and later as director of obstetrics and gynecology. At present Dr. Holden is attending obstetrician and gynecologist to French Hospital and consulting obstetrician and gynecologist to Bellevue Hospital and is active as consulting obstetrician and gynecologist to a number of hospitals both in New York and New Jersey. He is a Diplomate of the American Board of Obstetrics and Gynecology and Emeritus Professor of Obstetrics and Gynecology at New York University Medical College.



FREDERICK C. HOLDEN

EMILE F. HOLMAN, M.D., F.A.C.S., San Francisco, California, was born in Moberly, Missouri, in 1890. He received his academic degrees at Stanford University and Oxford University, and his degree in medicine from Johns Hopkins University Medical School in 1918. He was a member of the Commission for Relief in Belgium from 1914 to 1915. In 1930, he was visiting professor of surgery at Peiping Union Medical College, Peiping, China, and that same year won the Samuel J. Gross Prize in Surgery. From 1936 to 1937 he was vice-president of the American College of Surgeons. At the present time he is professor of surgery at Stanford University School of Medicine and an executive in the Department of Surgery of Leland and Stanford Hospitals.



EMILE F. HOLMAN

JOSEPH ANDREW HYAMS, M.D., F.A.C.S., New York, New York, is a graduate of the College of Physicians and Surgeons, Columbia University. At one time he acted as chairman of the Genito-Urinary Section of New York Academy of Medicine and of the Medical Board of Community Hospital. He has also been president of New York Physicians—Yorkville Medical Society. He is now director of urology at New York Post-Graduate Medical School and Hospital, Columbia University and of Gouverneur Hospital; attendant urologist to the Urology Reconstruction Hospital and consulting urologist to All Souls Hospital, Morristown, New Jersey, St. Francis Hospital, Port Jervis, New York, and Beth David Hospital, New York City.



JOSEPH A. HYAMS



Windsor Studios

JOHN E. JENNINGS

JOHAN EDWARD JENNINGS, M.D., F.A.C.S., Brooklyn, New York, was born in 1875 at South Rutherford, New Jersey. He attended Rutgers Preparatory School, Rutgers College and the College of Physicians and Surgeons, Columbia University. In 1925, Dr. Jennings was president of the Medical Society of the County of Kings and has been a Regent of the American College of Surgeons. He also holds the title of Lieutenant Colonel of the A.E.F., U. S. Army. He is now acting as senior surgeon to Brooklyn Hospital, surgeon-in-chief to St. John's Hospital, surgeon to St. Peter's Hospital, consulting surgeon to Huntington, Nassau, Beth-El, Norwegian, Lutheran, Bethany-Deaconess, Cumberland, Caldenonian, Brooklyn Woman's, Midwood and Bay Ridge Hospitals.



WILLIAM L. KELLER

WILLIAM LORAN KELLER, M.D., F.A.C.S., Washington, D.C. was born in 1874 at East Hartford, Connecticut. He is particularly interested in general and thoracic surgery. Soon after he was graduated from the Medical College of Virginia in 1899 he became acting assistant surgeon to the United States Public Health Service. From 1902 to 1935 Dr. Keller was a medical officer in the U. S. Army and served in all grades from First Lieutenant to Colonel. He retired from that service at his own request after thirty years of duty. Dr. Keller served on the surgical service of army hospitals throughout his entire military career. He was director of Profession Services with the Headquarters of the A.E.F. in France during the World War and was awarded the Distinguished Service Medal for this work. From 1919 to 1935 he was the chief of the surgical service at Walter Reed General Hospital, and during those same years was instructor in surgery at the Army Medical School, Washington, D.C.



HOWARD A. KELLY

HOWARD ATWOOD KELLY, M.D., F.A.C.S., LL.D., Baltimore, Maryland, received his academic and medical degrees from the University of Pennsylvania. He is a well known surgeon and x-ray therapist. In 1907, he was president of the Southern Surgical and Gynecological Society and in 1912 president of the American Gynecological Society. Dr. Kelly established a hospital in Kensington, Philadelphia, which was later incorporated as Kensington Hospital for Women. In 1892, he established another hospital in Baltimore which afterward was incorporated as the Howard A. Kelly Hospital. Dr. Kelly is one of the pioneer radiologists and purchased the first radium in 1904, and it was he who insisted upon the use of large amounts of radium. He also was instrumental in bringing Max Broedel from Leipzig for the purpose of illustrating Kelly's gynecological writings, and because of this, medical illustration in this country and elsewhere has been transformed. Dr. Kelly is now Emeritus Professor of Gynecology of Johns Hopkins University Medical School and surgeon and x-ray therapist to the Howard A. Kelly Hospital. He is the author of a number of textbooks and several hundred articles.

THOMAS JOSEPH KIRWIN, M.D., F.A.C.S., New York, New York, was born at Frederick, Maryland, in 1889. He studied at the University of Michigan, Tulane, Cornell, Columbia and Yale Universities, and is certified by the Board of Urology. He served as Captain of the U.S. Medical Corps, in France, during the World War. Dr. Kirwin has devised a number of instruments known as Kirwin vesical neck resector, Kirwin prostatic resector, Kirwin lithotritex and Kirwin radon implanter. With Dr. Lowsley he is the author of a number of books including "Textbook of Urology," and "Urology for Nurses," and has written many papers on urological subjects. Dr. Kirwin is a member of many well known medical and surgical organizations and at present is chief of the urology clinic, James Buchanan Brady Foundation and adjunct visiting urologist to New York Hospital, consulting urologist to Coney Island Hospital, Brooklyn, St. Vincent's Hospital, Montclair, New Jersey, Benedictine Hospital, Kingston, New York, and visiting genitourinary surgeon to City Hospital, New York City.



THOMAS J. KIRWIN

ARTHUR KRIDA, M.D., F.A.C.S., New York, New York, was born in Poland in 1888. He was graduated from Albany Medical College and his specialty is orthopedic surgery. He was formerly chairman of the Orthopedic Section of both the New York Academy of Medicine and the New York State Medical Society. From 1917 to 1919 he was a Captain in the U. S. Army Medical Corps. At present he is professor of orthopedic surgery, New York University Medical College; attending orthopedic surgeon to Bellevue; consulting orthopedic surgeon to Lutheran, North Hudson, U.S. Marine, Saratoga, St. Agnes, Beth Israel and Knickerbocker Hospitals. He has contributed to the profession many original ideas relative to knee joint surgery, congenital dislocation of the hip and splay-foot operation.



ARTHUR KRIDA

MAURICE LENZ, M.D., New York, New York, was born in Kovno, Russia, in 1890. He studied at New York University and Bellevue Medical School and at the College of Physicians and Surgeons, Columbia University. Dr. Lenz also studied at the Curie Institute in Paris, France, and at Freiburg, Germany. During the World War he was stationed at the base hospital in the south of France and served in the Medical Corps. Some years ago he was vice-president of the American Radium Society and in 1937 and 1938 was chairman of the Standardization Committee of the American Radium Society. At present he is chief of the Radiotherapy Department of Presbyterian and Montefiore Hospitals; consulting radiotherapist to United Hospital, Port Chester, New York, North Hudson Hospital, Weehawken, New Jersey, and associate professor of clinical radiology at Columbia University.



MAURICE LENZ



H. H. M. LYLE

HENRY HAMILTON MOORE LYLE, M.D., F.A.C.S., New York, New York, was graduated from Columbia University in 1900. He served an internship for two years at St. Luke's hospital. During the World War, Dr. Lyle was active as surgeon-in-chief to the American Ambulance Hospital. He organized and took abroad Evacuation Hospital U.S.A. No. 2. This was the first army hospital to be commanded and taken abroad by a reserve officer. He was made a Lieutenant Colonel in 1918, was also appointed consulting surgeon to the 77th Division in September, 1918, and was decorated for his services by the United States and England. Since 1931 he has been professor of clinical surgery at Cornell University Medical School, and is also attending surgeon to St. Luke's Hospital, director of Cancer Service, Skin and Cancer Hospital, attending surgical specialist to the United States Veteran's Bureau, District No. 2 and consulting surgeon to Elizabeth A. Horton Memorial Hospital, Middletown, New York, New York State Reconstruction Home, West Haverstraw, New York, and St. Luke's Hospital, Newburgh, New York.



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JEROME M. LYNCH

JEROME MORLEY LYNCH, M.D., New York, New York, was born in Ireland. He attended Queen's College, Cork, Ireland, and was graduated from Rush Medical College in 1895. He served as Lieutenant Commander of the U.S. Naval Reserve Transport "America" during the World War. He was an instructor in proctology at Cornell Medical School for five years and also surgeon and chief at St. Bartholomew's Hospital, New York City. For twenty-five years he has been professor of proctology and colonic surgery at the New York Polyclinic Medical School and Hospital. He is also consultant in surgery to the Neurological Institute, New York, Broad Street and Mary Thompson Hospitals. Dr. Lynch has contributed largely to the literature of his specialty. He is the author of the chapters on rectocolic surgery for Johnson's "Surgery," Woods' "Handbook of Medical Science" and Tice's "System of Medicine." He has also written "Diseases of Rectum and Colon" and "Tumors of the Colon and Rectum."



URBAN MAES

URBAN MAES, M.D., F.A.C.S., New Orleans, Louisiana, was graduated from Tulane University in 1900. He was made a Lieutenant Colonel during the World War. From 1929 to 1933 he was on the Board of Governors of the American College of Surgeons and has held important offices in other prominent surgical organizations. He is now chairman of the Executive Committee, professor of surgery and director of the Department of Surgery at Louisiana State University School of Medicine; consultant in surgery to Touro Infirmary and senior visiting surgeon to Charity Hospital of Louisiana at New Orleans.

RUDOLPH MATAS, M.D., F.A.C.S., New Orleans, Louisiana, was born in Bonnet Carré, Louisiana, in 1860. He studied in Paris, France, and Barcelona, Spain, and received his medical degree from Tulane University in 1860. He is Professor Emeritus of Surgery of both New Orleans Polyclinic Post-Graduate School and Tulane University. From 1894 to 1928 he was senior surgeon to Charity Hospital and for thirty years was the chief surgeon to Touro Infirmary. He was the organizer and director of Base Hospital No. 24, the Tulane Unit for service in France during the first World War, and he is a member of numerous societies both here and abroad. In 1926, he was the Henry Bigelow Medalist for distinguished contributions to the advancement of surgery. Dr. Matas is the author of many treatises and monographs on surgical subjects especially surgery of the blood vessels.



RUDOLPH MATAS

ROY DONALDSON McCLURE, M.D., F.A.C.S., Detroit, Michigan, received his academic degree at Ohio State University and his degree in medicine at Johns Hopkins University. He also studied at the University of Prague, Bohemia, in 1906. From 1918 to 1919 he served as Major of the Medical Corps, U.S.A., and was commanding officer of Evacuation Hospital No. 33, of the A.E.F. He acted as house surgeon to New York Hospital, assistant resident to Johns Hopkins Hospital and was instructor of surgery at Johns Hopkins Medical School for four years. He was assistant to Dr. Alexis Carrel from 1907 to 1908 at the Rockefeller Institute in the work on transplantation of organs, for which Carrel received the Nobel prize. Dr. McClure is the author of numerous papers in both experimental and clinical fields. At present he is surgeon-in-chief to Henry Ford Hospital, consulting surgeon to Receiving Hospital, extramural lecturer in postgraduate medicine, at the University of Michigan, and regional representative of the Commission on Admissions of Johns Hopkins and Duke Universities.



Blackstone Studios

ROY D. McCLURE

HOWARD C. NAFFZIGER, M.D., F.A.C.S., San Francisco, California, is a neurological surgeon. He received both his academic and medical degrees at the University of California. After graduation he received his surgical training at the University of California Hospital and Johns Hopkins Hospital. He is a member of a number of well known medical and surgical societies and is professor of surgery and chairman of the Department of Surgery at the University of California Medical School, surgeon-in-chief to the University of California Hospital, and neurological surgeon to U. S. Veteran's Administration Hospital.



H. C. NAFFZIGER



Underwood & Underwood

EMIL NOVAK

EMIL NOVAK, M.D., F.A.C.S., Baltimore, Maryland, specializes in gynecology. He is a graduate of Loyola College, Baltimore, and of the University of Maryland. He did postgraduate work in Berlin and Vienna and received an honorary degree of Doctor of Science from Trinity College, Dublin. Dr. Novak has written numerous articles chiefly in the fields of gynecological pathology and endocrinology. He is the author of "Menstruation and Its Disorders," "The Woman Asks the Doctor" and "Gynecological and Obstetrical Pathology" and of sections or chapters in Curtis' "Obstetrics and Gynecology," Lewis' "Practice of Surgery" and the "Oxford System of Medicine." He is now associate in gynecology, at Johns Hopkins Medical School, associate professor of obstetrics at the University of Maryland Medical School; gynecologist and chief of staff, Bon Secours Hospital, visiting gynecologist to St. Agnes Hospital and the Hospital for Women. He is the founder and first president of the Gynecological and Obstetrical Society of Baltimore.



CLARENCE R. O'CROWLEY

CLARENCE RUTHERFORD O'CROWLEY, M.D., F.A.C.S., Newark, New Jersey, was graduated from the College of Physicians and Surgeons, Columbia University, in 1904, and has specialized in urology for over thirty years. He is a Diplomate of the American Board of Urology and a charter member of the American College of Surgeons. He is also assistant professor of urology at the Graduate School of the University of Pennsylvania and is attending surgeon and chief of the Department of Urology of Newark City Hospital, and attending surgeon to Newark, Beth Israel and Presbyterian Hospitals, Newark, New Jersey, and St. Mary's Hospital, Orange, New Jersey. He is a past president of the American Urological Association and of the Society of Surgeons of New Jersey. Dr. O'Crowley is consulting urologist to a number of hospitals in New Jersey and a member of well known urological societies both here and abroad.



Garo

LOUIS E. PHANEUF

LOUIS EUSÈBE PHANEUF, M.D., F.A.C.S., Boston, Massachusetts, was born in Canada in 1884. His specialties are gynecology and obstetrics. He was graduated from Tufts College Medical School (summa cum laude) in 1913. He is the professor of gynecology at Tufts College Medical School, gynecologist and obstetrician-in-chief to Carney and Malden Hospital, and surgeon of the Department of Gynecology of the New England Medical Center. He is active as consulting gynecologist to Beth Israel Hospital, Boston, and to other hospitals in Massachusetts and Maine. He is also a member of numerous medical and surgical societies in the United States and Europe. In December, 1938, Dr. Phaneuf received the decoration of Officer of the Order of the Crown from King Leopold III of Belgium.

EUGENE HILLHOUSE POOL, M.D., F.A.C.S., New York, New York, attended Harvard University and the College of Physicians and Surgeons, Columbia University. At one time he was elected president of the New York Academy of Medicine, the American Surgical Association and the American College of Surgeons. During the World War he served overseas as a Lieutenant Colonel of the Medical Corps. At present he is professor of clinical surgery, Cornell University Medical College, senior attending surgeon to New York Hospital, Surgeon-in-Chief Emeritus, of the Hospital for Ruptured and Crippled, and consulting surgeon to French, Woman's and Presbyterian Hospitals, and to the Harlem Infirmary for Women and Children.



EUGENE H. POOL

JAMES TAGGART PRIESTLEY, M.D., F.A.C.S., Rochester, Minnesota, was born in Des Moines, Iowa, in 1903. He received his academic and medical degrees from the University of Pennsylvania and his Ph.D. in surgery from the University of Minnesota. He is a member of the American College of Surgeons, the American Board of Surgery and the Clinical Society of Genito-Urinary Surgeons. He is the head of a section in the Division of Surgery at the Mayo Clinic, and assistant professor of surgery at the Mayo Foundation, University of Minnesota.

*Gilbert Woodcock*

JAMES T. PRIESTLEY

DOUGLAS QUICK, M.D., F.A.C.S., New York, New York, was born in Ontario, Canada. He is a graduate of the University of Toronto Faculty of Medicine and specializes in the treatment of cancer and allied diseases. He is the former president of the American Radium Society and a member of numerous radiological societies. Dr. Quick became associated with the late Dr. H. H. Janeway as his assistant in 1916 and since that time has devoted his energies entirely to the treatment of cancer. It is Dr. Quick's belief that he and Dr. Janeway were the first clinicians in this country to devote all their time to the clinical care of malignant neoplastic diseases. This entailed both surgical and radiological care and served to combine surgery and radiology rather than leaving it separated in different hands. Dr. Quick has been in the capacity of assistant surgeon to City Hospital, assistant surgeon and attending surgeon to Memorial Hospital and director of radiology to Memorial Hospital.

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DOUGLAS QUICK

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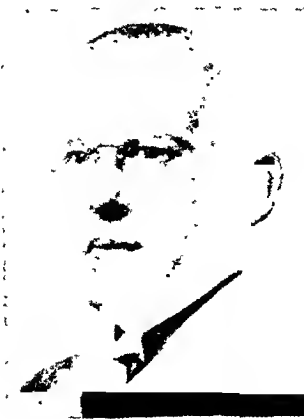
NATHANIEL P. RATHBUN

NATHANIEL PHILIP RATHBUN, M.D., F.A.C.S., Brooklyn, New York, was born in Springfield, Massachusetts. He is a graduate of Long Island College Hospital and a specialist in urology. He is the former chairman of the Genito-Urinary Section of the New York Academy of Medicine and acted as president of the New York Urological Society and the American Urological Society. He is the chief of urology to Brooklyn Hospital and consulting urologist to Lutheran, Norwegian, Beth-El, Bushwick and Eastern Long Island Hospitals.

*Harris & Ewing*

HUBERT A. ROYSTER

HUBERT ASHLEY ROYSTER, M.D., F.A.C.S., Raleigh, North Carolina, was educated at Raleigh Male Academy, Wake Forest College and the University of Pennsylvania. He served a one-year internship at Mercy Hospital, Pittsburgh, and was surgeon to Rex Hospital from 1897 to 1938. Dr. Royster has travelled extensively in order to pursue postgraduate courses and to observe the work of prominent surgeons both here and abroad. He was surgeon-in-chief to St. Agnes Hospital and consulting surgeon to a number of railway corporations. He was one of the founder members of the American College of Surgeons and of the American Board of Surgery, and in 1926 was elected president of the Southern Surgical Association. Dr. Royster is the author of three books: "Syllabus of Therapeutics," "Appendicitis" and "Medical Morals and Manners." He has also written numerous articles which have appeared in leading magazines and newspapers. In April, 1938, he retired from active professional work.



HENRY S. RUTH

HENRY SWARTLEY RUTH, M.D., Merion, Pennsylvania, a graduate of Swarthmore College and Hahnemann Medical College and Hospital, has devoted his professional activities exclusively to anesthesiology since 1924. At the present time he is the Editor of Anesthesiology, the official organ of the American Society of Anesthetists. He is also anesthetist to Hahnemann, St. Luke's and Children's Hospitals, chief of the Division of Anesthesia, Philadelphia General Hospital, chief anesthetist to Broad Street Hospital, Philadelphia, and clinical professor of anesthesia at Hahnemann Medical College and Hospital. Dr. Ruth has also held the office of president of a number of societies for anesthetists and is the vice-president of the American Board of Anesthesiology.

M. G. SEELIG, M.D., F.A.C.S., St. Louis, Missouri, is a general surgeon. He received his academic degree at Harvard University in 1896 and his degree in medicine at the College of Physicians and Surgeons, Columbia University, in 1900. He is a retired Colonel of the Medical Corps of the U. S. Army and a professor of clinical surgery at Washington University, consultant in surgery to Jewish Hospital, and director of pathology at Barnard Free Skin and Cancer Hospital.



M. G. SEELIG

JOHAN BENTLEY SQUIER, M.D., F.A.C.S., New York, New York, received his medical degree at the College of Physicians and Surgeons, Columbia University, in 1894. He was attending surgeon to the Department of Charities, New York City, for twelve years, and professor of genitourinary surgery at New York Post-Graduate Medical School from 1909 to 1924. He is the director of the Squier Urology Clinic, the originator of Columbia War Hospital and a member of the General Medical Board of the Council on National Defense. Dr. Squier resigned his position as professor of genitourinary surgery at Columbia University in June, 1939, and received the appointment of Professor Emeritus. He is the author of numerous monographs on subjects relating to surgery of the bladder and kidneys.



Peter A. Julev & Son

J. BENTLEY SQUIER

HENRICUS JOHANNES STANDER, M.D., F.A.C.S., New York, New York, was born in 1894 at Georgetown, Cape Province, South Africa. Dr. Stander studied at South African College, Harvard University, the University of Arizona and Yale University. At one time he was chemist to the Hercules Powder Company, associate in obstetrics to Johns Hopkins Hospital, on the house staff of the Royal Victoria Hospital, Montreal, and associate professor of obstetrics, Johns Hopkins Hospital. He is now professor of obstetrics and gynecology, Cornell University Medical College, obstetrician and gynecologist-in-chief to New York Hospital, director of Lying-In Hospital and chief of staff of the Berwind Free Maternity Clinic.



Kazanjan

H. J. STANDER



GRANT E. WARD

GRANT EBEN WARD, M.D., F.A.C.S., Baltimore, Maryland, was graduated from Johns Hopkins Medical School in 1921. Dr. Ward specializes in surgery and radium therapy. He is a Fellow of the American Congress of Physical Therapy and was chairman of the Eastern Section of that organization in 1935. Dr. Ward is a member of the American Medical Editors and Authors Association and of the American Association for the Study of Neoplastic Diseases. He is now associate professor of surgery, School of Medicine, University of Maryland; associate in surgery, Johns Hopkins University, assistant visiting surgeon and assistant dispensary surgeon to Johns Hopkins Hospital, visiting oncologist to Baltimore City Hospitals, and lecturer in oral oncology, Baltimore College of Dental Surgery, Dental School, University of Maryland.



J. HOMER WOOLSEY

JOHN HOMER WOOLSEY, M.D., F.A.C.S., Woodland, California, was born in New York in 1889, and was graduated from the University of California Medical School. Dr. Woolsey served in the U.S. Army Medical Corps overseas from 1917 to 1919, and has also been a member of the Board of Governors of the American College of Surgeons. He is now associate clinical professor of surgery at the University of California Medical School and surgeon to the Woodland Clinic. He is also the author of a number of articles on various aspects of surgery which have been published in national and state medical journals.

JAMES MORLEY HITZROT, M.D., F.A.C.S., New York, New York, was born in 1875 at McKeesport, Pennsylvania. He attended Princeton in 1897 and was graduated from Johns Hopkins University Medical School in 1901. At present he is consulting surgeon to New York Hospital, Nassau Hospital, Mineola, New York, North County Community Hospital, Glencove, New York, and Norwalk General Hospital, Norwalk, Connecticut.

ADRIAN V. S. LAMBERT, M.D., F.A.C.S., New York, New York, received his academic degree at Yale University and his degree in medicine at the College of Physicians and Surgeons, Columbia University in 1896. From 1939 to 1940 he was president of the American Association for Thoracic Surgery and at present is clinical professor of surgery at Columbia University. His specialty is general surgery.

HARRISON STANFORD MARTLAND, M.D., Newark, New Jersey, attended the College of Physicians and Surgeons, Columbia University, and after graduation interned for eighteen months at New York City Hospital. He then spent a period of two years in pathology and bacteriology at the Russell Sage Laboratory, after which he was appointed pathologist to Newark City Hospital. Dr. Martland entered the army in 1917 as a member of the Bellevue Hospital Unit. His services were so distinguished that he was made a colonel in the reserve corps. Dr. Martland's pathological museum at City Hospital, which was built up mostly through his own efforts, has come to be known as one of the best in the country. In 1916, Dr. Martland began to write for publication. Since then he has written more than fifty medical papers and two original books entitled "Punch Drunk" and "Dr. Watson and Mr. Sherlock Holmes." He also published a series of articles showing the results of occupational poisoning. During 1934 and 1935 he was the editor of the Section on Forensic Medicine in The American Journal of Surgery. In 1935, he received an honor that usually does not come during a doctor's lifetime: The Essex County Anatomical and Pathological Society established the Harrison Stanford Martland Lectures.



Original Articles

THE PAST HALF CENTURY AND MEDICAL EDUCATION

RAY LYMAN WILBUR, M.D.

President, Stanford University

SAN FRANCISCO, CALIFORNIA

FIFTY years ago medical education in this country felt the first sharp impact of the laboratory. Over the centuries medicine had been built up through observation and experience. Great figures, such as Hippocrates, Galen, Paracelsus and Vesalius, had been used as foundation stones in the building of medicine. Theirs were the voices of authority, for they had both knowledge and wisdom. It is remarkable how much the contributions of men like Hunter, Harvey, Jenner and Lister were used in the every-day work of the physician. The practice of medicine was an art, and only artists with unique personal equipment could gain leadership in it. The inklings of a new era wherein facts became supreme appeared with the rapid development of chemistry, which when applied to medicine began to indicate the possibilities of a study of the various body fluids and the changes taking place in them with disease. The beaker and crucible were soon joined by the microscope and thermometer in uncovering new knowledge of the way the body reacted to sickness. The microscopic enemies of man were brought to light.

In the eighties and nineties of the last century the studies of Pasteur, Koch, Behring, Ehrlich and others led directly to the destruction of the commercial medical schools which were in full blossom in America at that period. It was the costs of the necessary laboratories and the payment of the instructors working in them that took the bottom out of schools supported by student fees. Endowment funds or large appropriations for annual support were

required in order to give medical training that prepared for a medical practice based more and more on research and the laboratory.

At the same time the growing laboratories in the various fields of medicine made it imperative to require premedical training in chemistry, physics and biology. Greek, Latin and philosophy opened no laboratory doors, even though they did open the doors of the mind.

One can look back now and see the great drama that took place in medical education both in Europe and America. In the United States within a comparatively few years the number of commercial medical schools was strikingly reduced, university medical schools were organized, the length of the medical course was markedly increased, the number of medical students diminished, and there began that transformation that has advanced medical education in America so that it is the peer of that of any other country in the world.

It was the physician who saw the need of using the constantly growing knowledge and who was willing to make the personal sacrifices that go with change. The American doctor, acting through the American Medical Association, began a campaign for better instruction, better procedures in licensure of physicians and surgeons and larger campaigns for the general support of medical education. The American public was far behind the profession in its understanding of what was required, so that we have had fifty years of constant battles against ignorance and those who profited

in some degree from letting things go as they were.

It has not been easy to keep medical education in tune with discoveries and change. The death of any educational institution is always accompanied by many signs of distress and by strong opposition from those associated with it as faculty or as alumni. When we realize that thirty odd years ago Illinois had fifteen medical schools, Missouri fourteen, Maryland eight, Kentucky seven and Tennessee ten, we can best understand what this process has been. There were homeopathic and eclectic schools, as well as those that were called allopathic or regular. The disappearance of those words from daily use indicates the shift from doctrinaire points of view in medicine to medicine as a science.

Medicine itself had to undergo a transformation in the minds of the profession and in the minds of the public. So unusual were the developments coming out of the laboratory with the discoveries of the tubercle bacillus, the typhoid bacillus, the pus forming organisms, the plasmodium of malaria and on through to the spirochete of syphilis, that there was a constant uncovering of new information in those fields of medicine that had been most constantly cultivated over the years. The blind spots became fewer. Remedies became more specific and effective. Antidiphtheric serum and salvarsan began their life-saving service, while the surgeon was daring to explore more and more of the human frame to uncover and relieve successfully existing pathologic conditions.

Every part of the medical curriculum felt the impulse from the laboratory, the autopsy table and the operating room. Pathology became a key subject and influenced profoundly both medicine and surgery. New editions of the textbooks of anatomy came out without emphasis upon how to reach the organs of the body without involving the peritoneum. Aseptic surgery opened up a new era in the treatment of all sorts of pathologic conditions that had been allowed to destroy the

patient or to reach proportions so that an operation was looked upon as a last resort. Not only was the content of the medical course markedly changed but it was soon increased in length and the intern year became almost universal.

The commercial medical school had depended largely upon the lecture system, which was no longer applicable to much of the work of the laboratory. The need of special training and of laboratory work with students as well as with specimens, and the development of necessary research brought about the appointment throughout the country of trained men in physiology, pathology, bacteriology, anatomy, pharmacology and biochemistry. These men had regular academic standing and salaries whenever the medical schools were associated with universities. More and more schools either united with others or sought university connections. Medicine in a few decades went from a modified apprentice system through didactic lectures by members of the profession, who divided the curriculum among the Faculty, to a university status.

There was steady pressure to develop men in the fields of medicine and surgery who could parallel in training and in teaching those who were soon working upon the fundamental subjects of the medical course. The question of the full-time clinical professor was agitated, particularly following the report of the Carnegie Foundation for the Advancement of Teaching made by Abraham Flexner in the spring of 1910. This exhaustive report fitted right into what had been done by the Council on Education of the American Medical Association and attracted the attention of educators in this country and throughout the world. It can be considered the text of the drama of change in medical education.

The significance of scientific training in such a field as the care of the sick has been better understood with the passage of each year of the past fifty. Authority based on long years of practice was replaced by the facts of the laboratory and their inevitable

relationships to the welfare of patients. The plug-hatted doctor with his beard and long-tailed coat was soon replaced in the public eye by the white-coated surgeon with his rubber gloves. Medical faculties took on a different form. The scientist of the laboratory assumed a too predominant control of the medical curriculum. Only those of us who have lived through this whole fifty years and have seen these changes can grasp how striking they have been.

Along with the increase in laboratories, their personnel and costs came the rapid increase in hospital beds throughout the country. Not only did the hospital add the laboratory to its equipment but it also accepted much of the responsibility for the training of the various lieutenants of the doctor who are required in modern practice. The trained nurse, physiotherapist, dietitian, radiologist, laboratory technician and social service worker all had to be prepared to join the physician, the medical student, the intern and the hospital resident at the bedside of the patient. The training of the candidate for his medical degree was but part of the educational projects taken over by the hospital and its staff.

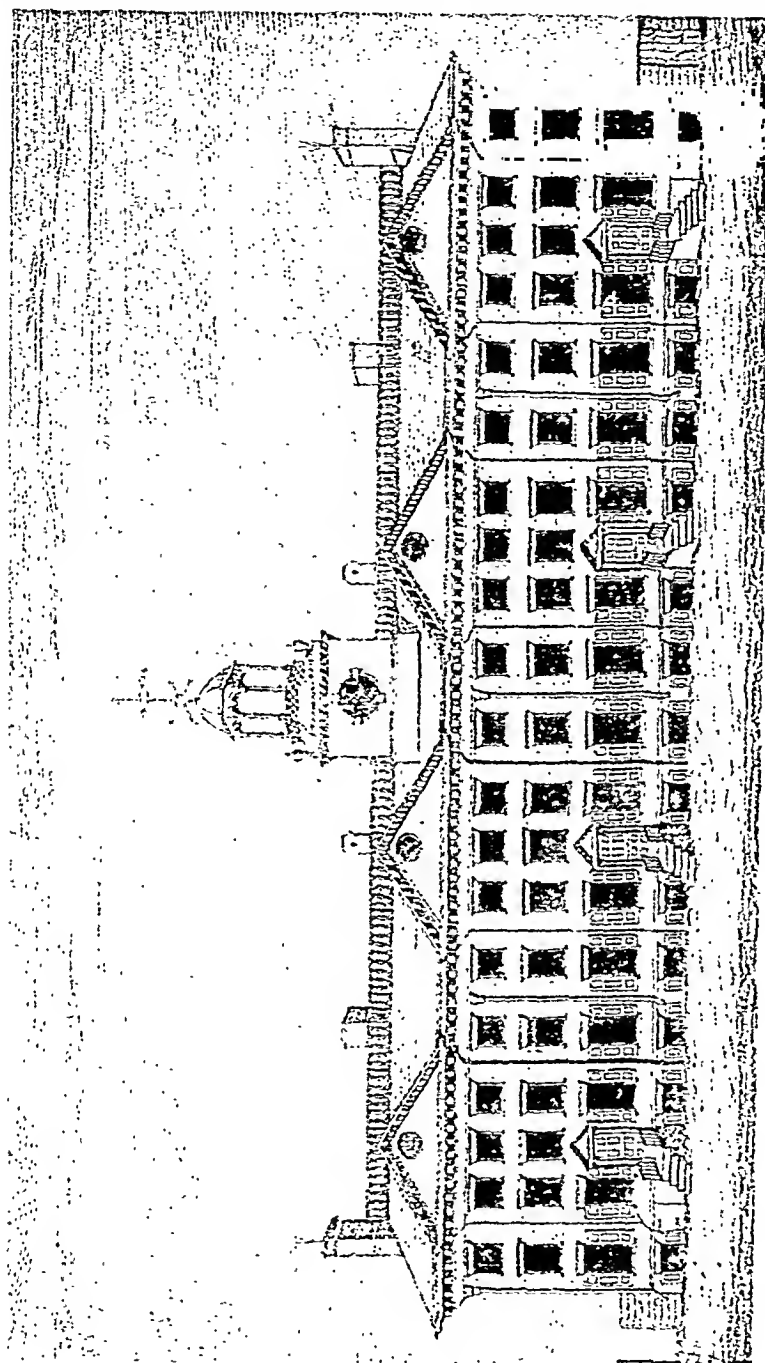
We cannot separate the growth of our hospitals in number and size and their constantly rising position in medical care from medical education and the education of the public in the help that the modern physician can give. As they have become necessary for both the early and late training of the doctor, so have they become indispensable in offering facilities impossible to create in the home. These facilities are of value in the day-to-day training of the medical student, whose opportunities are almost inconceivably better than they were when he was an apprentice to a practicing physician.

It must always be remembered that the quality of the better medical student has not changed, and that the human body approached with skilled senses and a trained, active physician's mind will yield more clinical information than can ever be

squeezed out by a piece of machinery, no matter how elaborate the machine or its surroundings may be. The main object of medical education for the last half century has been to train a worthwhile young person to accept with a fair chance of success the usual responsibilities facing a family physician. There have been many variations but the state examining boards have persistently kept this as their ideal in spite of the addition of new subjects and the lengthening of the preparatory and medical courses.

So rapid were the developments in the practice of medicine itself that it speedily branched off into specialties. One after another they flared on the medical horizon and for a while it seemed that the family physician of the past was doomed. The faculties of the medical schools were confronted with the difficult problem of how to fit in the training of the specialist with that of the general practitioner. There was a constant struggle within each medical faculty and between its members for the curriculum hours of the student to see that he had some experience and training in every field of medicine. In fact the curriculum became so engorged with old and new subjects, so mixed up with lectures, demonstrations, clinics and amphitheater operations, so tangled with legislative requirements, that the medical student was driven almost beyond endurance. The Association of American Medical Colleges, working with the Council on Medical Education of the American Medical Association, after many struggles brought about a more reasonable set of requirements. It was simply impossible to get all of medical lore into a crowded course of study and into a brain no matter how receptive.

The specialties have largely been pushed up into the hospital years and have become electives for medical students. Many a faculty has had to hold down a brilliant teaching specialist whose enthusiasm for his own subject made him lose sight of the need of a well rounded training for the young doctor.



COLUMBIA COLLEGE IN 1790

King's College Medical School occupied quarters in the above building 1767-1813

CONSTANT CHANGE

One thing that has been constant in all medical education in the last fifty years has been change. While there have been delay, conflict and mistakes, there has also been steady progress, at times almost whirl-wind in its effects.

Perhaps we can best understand what has taken place in the fifty years if we think of the present responsibilities of the young physician and of what he is expected to learn, compared with what was formerly available to the medical student in the ordinary American medical college and what those who called him in wanted in the way of service. The increase in the range of available facts is so much greater than then, that it is marvelous we are able to bring within our medical curriculum the essential knowledge that is tested in such examinations as those given by the National Board of Medical Examiners and by some of the State Boards. So basic are the fundamental requirements in science that we now take them for granted. So manifold are the different technical processes that the medical student must learn and so many are the procedures of the laboratory with which he must be familiar, that at times the emphasis seems to be taken off clinical work as such, and it seems as though we were trying to develop a laboratory specialist rather than a physician. Fortunately, in more recent years American medicine, while firmly based on the laboratory and its findings, has become more clinical in its emphasis. Since it is possible for a well trained physician to diagnose with the use of his own senses over 80 per cent of the ailments that are presented to him, it is clear that this reemphasis on clinical training is in the right direction. It was the development of clinical sense that made competent doctors out of the graduates of even the poorer commercial medical schools. What some of the men who were trained in these schools were able to accomplish in the way of leadership in every branch of medicine indicates that the prac-

tice of medicine is more an individual affair than something that can be acquired through industry alone, even under the best of conditions.

In viewing the present state of medical education it is important to realize that the size of buildings, the density of equipment and the number of hospital associations can not be used as indicators of the quality of instruction given a student. The one fundamental is a properly prepared student in the intimate presence of the patient under the guidance of a clinician. Medicine as an art is being forced upon us more and more as preventive measures limit frank disease and the reactions of the central nervous systems of patients to the floods of contacts to which they are exposed engross more of the attention of the physician.

One of the most disturbing facts in regard to medical training is that we have not succeeded up to date in giving all of our medical students an adequate understanding of psychologic processes and of psychiatry in general. In fact, the emphasis on the laboratory and its findings has been a distinct handicap in this respect. Certainly it is difficult to train medical students in the art of medicine; but unless there is a clear understanding on the part of medical faculties and of students that man is more than a bunch of reactions inside of a sensitive skin and that the personal equation is important in every patient, we are apt to continue to encourage the growth of more cults and isms. We must admit that side by side with the flowering of the science of medicine, with its astonishing services to man and society, there has been a steady development of cheap and flabby schools for osteopaths and chiropractors, and that the Chinese herbalist and the Eddyite flourish in the land. To appreciate the product of a great medical school is an acquired taste based on reason and understanding. For many the plausible doctor of magic gives greater emotional satisfactions than does the well trained doctor of medicine, even if these patients end prematurely in the cemetery.

The doctor, rather than the ordinary citizen, has been the creator of better conditions for medical education and practice, and has been the backer of protective legislation against unsound or inadequate training of those who care for the sick.

MENTAL DISEASES

There are more patients available in psychiatry in our hospitals than in almost any other branch of medicine, and less use is made of them than of any other hospital patients in medical education. Yet it is evident that these hospitals are to grow and that the percentage of patients with some form of mental disturbance is bound to increase. Mental conditions have been persistently neglected in American medical education. We must admit that we have lagged in our progress in this vast branch of medicine. Each year in each state the legislature is implored to provide more beds for the insane. The homes of our present cities must disgorge their addled members onto the hospital.

It is our American habit to seek quick relief, to be willing to be operated upon, but not to be willing to accept long and painful responsibilities in medical care. The doctors have fallen into these American ways and as a group psychiatry in all of its manifestations has passed them by. Our medical schools have for the most part been weak in this subject and in training in the physical measures that assist in treatment. Medical jurisprudence and social medicine have been sadly neglected at a time when the profession is being brought actively into nearly every part of our political, industrial and community life.

PUBLIC HEALTH AND PREVENTIVE MEDICINE

In fifty years, for all practical purposes, we have seen the birth and growth of public health and preventive medicine, with their profound effects on morbidity and mortality among our fellow human beings. Wherever the medical profession

has been able to find some procedure, such as adding chlorine to drinking water, which would keep living organisms from getting into our bodies, preventive medicine has been an astounding success. Vaccination against smallpox could be universally successful; but whenever individuals have a choice as to whether they will or will not accept established preventive measures, we find a considerable percentage of failure. There is no denying the fact that in spite of the advances that have been made in every field of medicine we still have a large percentage of our population filled with prejudices and the easy prey of plausible persons without scientific understanding or training. Just how much of this can be blamed on our medical schools is hard to say; but certainly they have been slow to give prevention its place in every clinic, and the ordinary physician has been reluctant to absorb the responsibility of educating the public.

No medical course could be complete at the present time without training in the field of public health, and yet many of our medical schools deal with this subject in a perfunctory manner.

Somewhat anomalous it is that certain separate schools of Hygiene and Public Health have been established in this country before Public Health was made a department of consequence in every medical school. Only by special emphasis and financial support will public health take its proper place in the training for the degree of Doctor of Medicine.

RESEARCH

The study of each individual patient is a form of research. The doctor's life is devoted largely to performing such research or using the benefits that have come through the persistent research of others in every field of science. Every new discovery in science has been gone over by physicians in the hope that it could be applied to medicine. This has been the age of practical discoveries and of the development of the rays, beginning with the Roentgen rays. The

co-operation of the physicist, chemist and biologist has been sought everywhere by the physician.

Illustration of the vast influence of research in all medicine is everywhere to be seen and the medical school has done much to keep abreast of new discoveries.

Medical education has had to help develop personnel for such subjects as anatomy, physiology, pharmacology, bacteriology, pathology and biochemistry, and to use the information obtained from their work in the care of the sick.

In the medical faculty, research is possible only when there is sufficient over-staffing so that there is time to go beyond the routine of the day and routine teaching. This means increased costs. The greatest pride of the medical profession in this country is that it has been instrumental in bringing together large sums in the universities and in the special research laboratories which have made it possible to carry on advanced medical research in constantly increasing volume, much of it in the presence of the medical student. In fact, we have done as much medical research as the funds available for the purpose have permitted. Some medical schools have had greater success than others in securing gifts, but all of them have participated to some degree in exploring the unknown. It is easier now to secure funds for medical research than for medical education.

Every step that we have taken to advance the quality of medical instruction in the United States has resulted in greater costs. The cost per student is now higher in medicine than in any other part of our universities, but the social return is large if a good job is done. The medical profession has constantly sought to build up the funds of the teaching institutions. The sums obtained over five decades have been very large.

If we compare the medical schools of the last few years with those of thirty or forty years ago, we find that at that time the budget of the school was derived almost exclusively from student fees and that

many of the proprietary schools profited either directly or indirectly from these fees. Now private endowments, or taxes for state supported institutions, provide over 60 per cent of the income of medical schools.

The qualifications of the faculty have changed from those of practicing physicians without special training dividing up the teaching of the subjects of the required medical curriculum, without facilities for research, to faculties with a considerable percentage of thoroughly trained individuals devoting themselves largely to teaching and research and receiving regular salaries. The voluntary clinical worker and teacher still carries a large part of the clinical and hospital care of patients and of the practical instruction of medical students.

Perhaps most significant of all has been the control of hospitals, either university hospitals or public hospitals, by the staffs of the medical schools. This bringing of the hospital directly into the medical school has played an essential part in making the laboratory and its findings effective in the care of the sick.

THE SPECIALIST

The past half century has seen the rise of the specialist. He was inevitable. Surgery made so many new demands both in training and the use of special procedures and techniques that the surgeon early began to be distinguished from the physician. After the work of Lister and others the rapid growth of the specialist in surgery could not be avoided. It is a long stretch from the domain of the surgeon of the nineties to that of today. No part of the body is now inaccessible; but it has taken many subdivisions of surgery to bring this about. Gynecology had its period of rank growth. Obstetrics, while formerly almost a universal chore, is now an accepted specialty. Just as in an automobile plant one artisan spends his day in winding up one screw, so now in medicine some specialists only tear out tonsils or bore prostates, and others are allergists.

These refinements are too specific for the run of medical education. Certainly, the undergraduate medical curriculum has not had and will not have the time or the energy for training in more than the broad principles back of the more refined specialties. The development of postgraduate instruction, which for much of the last fifty years has been of a rather shabby and transient character, now has taken a form in several centers that gives promise for the development of selected men to as high a degree as is possible anywhere in the world.

The growth of special boards to give certification to those who complete an adequate course of training in one of these specialties is one of the more recent steps in advanced medical education.

EDUCATIONAL PLANT

The principal requirements of the commercial medical school of fifty years ago were lecture halls, a few microscopes and a dissecting room. Some sort of association with hospitals was also essential and outpatient clinics were the rule. If we compare the present plants of our three score and ten medical schools of today with the best of the old commercial institutions, we can

more completely sense what has taken place.

The library of the medical school provides a reliable guide in its activities. The number of subscriptions to medical journals is an indicator which tells us just what kind of a medical school it is; for the larger the subscriptions to good journals and the greater their use the more effective the medical school. The growth of medical libraries in nearly every large center of population presages a great future for medical education.

A LOOK AHEAD

We must build the future on the past. These five decades had their foundations in centuries of devotion to the care of the sick by men of genius and by those of ordinary mind but with an extraordinary sense of service. We can look forward to the next half century confident that in our present scheme of medical education we have built into medical practice the best in science and have trained thousands of men and women who will correct the present inadequacies, fit into our changing civilization as we have done and always keep medicine in the forefront by applying their knowledge to human relief and happiness.



SURGICAL INTERNSHIPS OVER THE PAST FIFTY YEARS

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IN the year 1892, almost fifty years ago, a young physician received his degree from a midwestern university. His medical course had been completed in the usual three-year period, and like most of his classmates, he immediately entered practice in a small town in a neighboring state, without the advantage of an internship.

During his first year in practice, a patient was encountered who presented unmistakable signs of that new American discovery, appendicitis. Without skilled assistance or a competent anesthetist, and operating upon a patient on an improvised table in the home, this young man, with courage worthy of a McDowell, performed the first laparotomy ever done in that part of the country. Unfortunately, his daring was not rewarded with good fortune; for this turned out to be a case in which the operation was successful but the patient died. Feeling ran high in the little community, there were mutterings against this dangerous new method of doctoring and even threats of mob violence.

It was just before the Fourth of July, and in the annual parade down Main Street was a float on which stood two burly butchers wearing bloody aprons and holding up for the gaping crowds to see, a gory mass of sheep's intestines taken from the dummy figure of a patient stretched on a butcher's block. So intense was public feeling that the young, would-be surgeon was advised to leave town for the day, and he did so, taking his wife on an all-day picnic.

Gratifying to relate, the young doctor returned home late that evening and next day went on with his practice. Later, he had the hardihood to attempt further laparotomies which were attended with

success. Eventually, he spent a year as a graduate student in Vienna and became a well qualified surgeon, according to the standards of his day. His life epitomizes, perhaps, the average educational preparation of a surgeon of fifty years ago in most parts of the country. Clinical clerkships had just been introduced at Johns Hopkins, internships were few and far between and residencies were in their infancy. Medical schools were yet to undergo the regeneration which followed the Carnegie Survey of 1910, and few hospitals indeed pretended to any form of organized education for their staffs. Americans were almost entirely dependent on European centers for graduate experience.

One sign of the weakness of medical school teaching of fifty years ago was the popularity of the organized "quizzes." These extracurricular exercises were presided over by outstanding young faculty members who were noted for their vigorous, almost slave-driving methods, as they hammered the multitudinous factual material of the course into their charges' heads. Certain of the quizzes, particularly in New York City, attained wide reputation. Besides their standing as aids in preparing for school and state board examinations, these quizzes also exercised the function of informal internship placement bureaus. There was keen competition between the various quizz masters to place their disciples in the few desirable hospitals then in existence. Their charges were coached with great assiduity, so that they might stand high in the competitive examinations given by these hospitals.

Among the quizzes, none was more famous than one of more than seventy students presided over by Dr. William S. Halsted. In collaboration with Dr. George

E. Monroe, he improved upon the traditional quizz sessions by giving his students practical exercises in the laboratory and at the bedside. Through all of his experiences, as an undergraduate, an intern and an attending staff member in New York, he had had ample opportunity to observe the development of students through their internships at the New York, Bellevue and Presbyterian Hospitals, and into their early years of practice. From these observations, he was convinced that the methods then in vogue of training young surgeons, first through a surgical internship and later through years of struggle in general practice, with the eventual emergence of a fortunate few as surgical specialists, was wasteful of educational resources and did not furnish the public with surgical service of sufficiently high quality.

In fact, he was convinced that a vicious circle had been set up. Hospitals, in order to attract the more promising candidates, sedulously cultivated the reputation of being very generous in giving a large number of operations to their house surgeons. In order to curry favor with their house staffs, the younger attending surgeons allowed their interns to do a great deal of operative work for which they were not adequately prepared. As it turned out, few house surgeons had sufficient opportunity to apply what technical skill they acquired during their early years in practice, and much of it was lost through disuse. Hence, a situation was created which in the long run was to work to the disadvantage of the intern, the young surgeon in training and the patient.

At this point, one of the romantic episodes of medical education occurred as an aftermath of a laboratory disaster. Dr. Halsted, during studies of peripheral nerve distribution, heard of a new local anesthetic drug. Obtaining a quantity, he carried out a series of injections of nerve trunks in his own body, systematically mapping out the resultant insensitive areas. Cushing has given Halsted the credit

for being the pioneer in nerve block anesthesia. Unfortunately, it was not until Dr. Halsted was in the grip of cocaine craving that he became aware of its habit-forming properties. For a time it seemed as if his career was ruined, but devoted friends rallied to his aid and instituted measures to free him from his addiction. Among these friends was Dr. William H. Welch, then a young pathologist in New York who was instrumental in persuading him to throw in his lot with the infant medical school recently founded in Baltimore, Johns Hopkins. Dr. Halsted was appointed to the chair of surgery there on March 11, 1889.

Here was an event which was to alter profoundly the course of surgical education. Halsted was keenly aware of the defects of the system of surgical training in New York of which he had been an influential part and determined to avail himself fully of the opportunity presented at the Johns Hopkins Hospital to start *de nouveau* with an entirely new educational idea. The result was the long-range plan now famous as the Johns Hopkins residency system, in the development of which Osler, Kelly and Williams were active collaborators. The more promising of his students, after a year of straight internship, were allowed to enter a period of residency, extending over an indefinite period of years. Only one was carried through to the final position of chief resident, but the others were placed in clinics elsewhere to continue their training. Because of Halsted's extremely meticulous technic and consequent slower and more deliberate method of operating, many surgeons who visited his clinic came away with a prejudice against his methods. Also, because of Halsted's absorption in laboratory research, his residents tended to become dominant figures and seemed to cut unduly into the preserves of their immediate superiors on the attending staff. As a consequence, a resistance to the idea of residencies was built up in other centers, which it has taken almost fifty years to overcome. In fact, the conflict between the

old and the new still goes on in our midst, dissenters maintaining that the residency system narrows the young surgeon's interests too early. They feel he never can become a well rounded physician without a few years of experience in general practice. While there is much to be said for this point of view, the present trend is all in the other direction. The requirements of the American Board of Surgery and the American College of Surgeons make it increasingly difficult for the general practitioner to specialize by means of the old informal method of gradually narrowing the scope of his practice.

EVOLUTION OF SURGICAL INTERNSHIPS

For a clear understanding of the complicated picture presented by modern surgical internships, we must delve into their backgrounds. Only then do the reasons for the different arrangements which we call *straight*, *mixed* and *rotating* become apparent.

During the five decades since 1890, most of the history of the evolution of modern surgical internships has been written. Very little change had marked their course for the previous century since their introduction at the Pennsylvania, New York and Bellevue Hospitals as house surgeonships after the European pattern. At the Massachusetts General Hospital, the term, "house pupil," was used, and like so many good Boston customs has been preserved until the present day. Following the English system, practically all of these services were "straight," the preparation of the resident physicians in these early teaching hospitals being either for a medical or a surgical career. It must be remembered that the general hospitals during the nineteenth century consisted, in most instances, of only three services: surgery, medicine and obstetrics. At the old New York Hospital on lower Broadway, the house surgeon and the house physician alternated in the delivery of uncomplicated cases in the lying-in ward.

The idea of specialty services in other fields has largely grown up during the past fifty years. During that period pediatrics, neurology, psychiatry, neurosurgery, ophthalmology, otolaryngology, urology, orthopedics, obstetrics and gynecology and other specialties have grown to full stature. Many of them were housed in separate hospitals for eye and ear patients, the ruptured and crippled, the lying-in, the child and the insane. As a consequence, internships in the larger general hospitals were limited in scope, tending to remain "straight" at older institutions as the New York and Massachusetts General Hospitals, or "mixed" as at Bellevue, but ending as either house surgeon or house physician. So fixed were these patterns, based upon an appreciation of the value of prolonged exposure of an intern to one service, that they have persisted up to the present day. Without much question, the preservation of this ideal of prolonged training on one service paved the way for the development of the modern surgical residency.

Around 1890, however, the course of graduate education indicated by the experience of these early leaders in the field was almost submerged by a surge of hospital building, with a sharp rise in the curve depicting the numbers of hospitals, beds and interns in the country.* These newer hospitals, because of the demands of the various newly recognized medical and surgical specialties, were forced to set aside beds for the care of these problems, increasing the number of services from the basic three above mentioned to as many as fourteen.† Since it was not practicable, in the hospital of average size, to staff each service with a group of interns, it was inevitable that there would be a great increase of rotating internships to furnish the needed house staff coverage. Curiously, no standard form of rotation emerged,

* Internships and Residencies in New York City, p. 38, 1934-1937.

† Internships and Residencies in New York City, p. 163, 1934-1937.

except in states where it was fixed by law. During the recent New York survey, for example, out of sixty general hospitals inspected, no two of the rotating internship plans were identical. However, a considerable number gave their interns one or more periods of senior assignment which they called houseships. Carrying over the old tradition that the house surgeon should be allowed to perform major surgery under supervision, these senior rotating interns were permitted the same privilege. Aside from the objection to allowing one so inexperienced to practice on human material, even under close supervision, there were other more objectionable features. The chance to take scalpel in hand and perform a laparotomy came to be regarded as the final reward of the intern's labors. No matter how much he was exploited as a junior by an excess of routine duties, he could be kept contented if he could look forward to his share of appendectomies, herniotomies, hemorrhoidectomies and other operative procedures. Understandably, the number of operations "handed" to each house surgeon was a matter of wide comment among his mates on the hospital staff, and inevitably among prospective candidates for internship appointments. This overemphasis on technical surgery gave medical students a false idea of the place of surgery in practice, misled them as to the true educational value of the internship and encouraged too many practitioners without real aptitude or adequate experience to assume heavy responsibilities for which they were not prepared. Some of these men, of course, were fortunate enough to obtain adequate graduate training under preceptors in this country and abroad, and eventually emerged as thoroughly qualified surgeons; yet they remained a minority.

There are other factors responsible for the large number of general practitioner surgeons. The advancing frontier throughout the nineteenth century required doctors practicing in the new communities to deal with every case encountered, surgical or

medical. Those of great natural ability did remarkable work, considering their preparation. Dr. William Wardell Mayo, the father of Dr. Charles and Dr. William Mayo, a general practitioner in Le Sueur, Minnesota, first came into prominence as a skillful surgeon in connection with his care of the victims of the Sioux Indian outbreak of 1862, and later after a tornado which wrecked the town of Rochester, Minnesota. In most instances, men of this type in their earlier years were without adequate hospital resources, and the surgeon's success was dependent on his ability to improvise an operating room in the patient's home. We must not forget that the laboratory examinations which are now an accepted part of a complete diagnostic study, together with the requirements incidental to modern aseptic surgery, hardly made their influence felt before 1890.

The twenty-year period from 1890 to 1910 was characterized chiefly by a rapid increase in the number of medical schools, students, hospitals and interns. Actually, the growth of the hospitals failed to keep pace with the multiplication of schools, for in 1904 the *Journal of the American Medical Association* reported that there were internships for less than half of the medical graduates and that few of these were of good educational standing.

In 1914, the American Medical Association began to issue its annual compilation of internships, but it was not until 1920 that the hospitals caught up with the procession and provided enough internships to make this experience available to all graduates. Consequently, it has been only during the past twenty years that practically all medical students have been assured of at least one year of hospital training before entering practice. During so recent a period have occurred practically all of the dramatic alterations which have so completely changed the complexion of modern surgical internships. In the face of a rapidly increasing number of residencies, they have had to revise their function markedly. The house surgeonship promises

to become largely a vestige, and the surgical internship merely an introductory period of training in diagnosis and methods peculiar to a surgical service. Some hospitals have gone so far as to abolish the surgical internship entirely, transferring its functions to the assistant residency and residency, but requiring a previous general medical internship as a groundwork. It seems likely that some form of surgical internship will survive, probably of mixed type such as a year consisting of six months each of medicine and surgery, which may serve as a foundation not only for advanced training in surgery, but in medicine, pediatrics, any of the various specialties or for any of the additional types of preparation needed for general practice.

As to the number of surgical internships annually available over the past fifty years, the recorded statistics give very little reliable information. Only within the past decade have the internships listed in the Educational Number of the *Journal of the American Medical Association* been differentiated as to whether they are rotating, mixed or straight. An examination of the straight internships offered over the last five years appears to indicate that those of surgical type have remained at a more or less constant level.

When the data as to surgical residencies is examined, however, there is quite a different story. In 1935, 145 hospitals reported a total of 449 surgical residencies

of all types; while in 1940, 230 hospitals listed a total of 788 residencies, assistant residencies and surgical fellowships, or a gain of more than 87 per cent. These figures are, of course, exclusive of residencies listed in other surgical fields, such as gynecology and obstetrics, ophthalmology, otolaryngology, orthopedies, urology, malignant disease, neurosurgery, and plastic, thoracic and traumatic surgery.

The future of surgical internships will depend entirely on events still in the making. We must not forget that the first list of surgical residencies was not issued until thirteen years ago. Only within the past five years has the American Board of Surgery come into being, and has the American College of Surgeons attempted to classify acceptable residencies. In the face of a world at war, no one can accurately predict what tasks our profession and its hospitals will be asked to assume.

Someone has called the World War II a war of miscalculation. So far, we Americans have an opportunity to size up the situation, plan thoughtfully and efficiently, and learn from the mistakes of others. In the job of utilizing our clinical resources wisely to supply an adequate number of doctors to meet the needs of the country, there is no task more pressing than that of adjusting surgical internships and residencies, so that resources available for teaching may be wisely and efficiently used.



SURGICAL OPERATIONS FIFTY YEARS AGO

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IN accepting the invitation to contribute my personal experience on "Surgical Operations Performed Fifty Years Ago" for the semicentennial number of the American Journal of Surgery, it occurred to me that the most effective introduction to the subject would be to reproduce the image of a representative American surgeon operating in a surgical clinic typical of the American scene of fifty years ago, just about the time when the Listerian revolution was beginning to assert itself in this country.

The *Journal* has been most happy in selecting as a fitting frontispiece to its semicentennial issue an artistic reproduction of the now famous painting by Thomas Eakins (1844 to 1916) which so faithfully and admirably depicts the fine, intellectual and kindly personality of Dr. D. Hayes Agnew, one of the ablest and most honored master surgeons of the past generation, who is seen holding one of his celebrated clinics at the Pennsylvania Hospital in Philadelphia, in 1889.¹

¹ This portrait is now at the Wistar and Horner Museum of the University of Pennsylvania. It was presented at the annual commencement of the Medical School at the University, on May 1, 1889, by the undergraduate classes in honor of Professor Agnew on the eve of his retirement from active teaching. Dr. Agnew is shown leaning on the low railing of the amphitheatre in an easy posture, having just completed an excision of the breast for cancer, still holding the scalpel in his left hand (he was ambidextrous). All the figures were taken from life, including that of his successor, J. Wm. White, his first assistant. The painting is justly regarded as one of the masterpieces of Thomas Eakins, that famous artist who made a specialty of medical subjects.

In the treatment of this subject, the painting is an amplification of the portrait of Dr. Samuel D. Gross, done by the same artist. The picture incidentally shows an interesting change in surgery, the white garments of Dr. Agnew and his assistants being an innovation, due to antiseptic surgery, unknown in Gross' time.

The following is the inscription on the frame: "D. Hayes Agnew, M.D., chirurgus expertissimus; scriptor et doctor clarissimus; vir veneratus et carissimus," which, being translated, reads: "The most experienced

To those of us who have lived and participated in the surgical life of the pre-Listerian period, this portrait of Agnew and his clinic has a special appeal as it reproduces with absolute fidelity the dawn of the new surgery as it was beginning to appear above the horizon in every one of the leading hospitals and surgical centers of America and throughout the world.

RECOLLECTIONS OF A PRE-LISTERIAN INTERNSHIP

Since I am expected to give some account of personal impressions and experiences, I trust I may be excused for speaking in the first person, as I might as well begin with the earliest recollections of my medical career which began as a matriculate of the Medical School of the University of Louisiana (now Tulane), in the fall of 1877, and as an intern of the Charity Hospital of New Orleans from 1878 to 1880, when I was graduated as an M.D.

Thanks to the opportunities given me by my internship, I had ample occasion to acquaint myself with the operations and methods of wound treatment which were in vogue at the hospital at a time when Pasteur's discoveries and Lister's application of them to surgery were still in doubt and dispute, despite the fact that Lister had enunciated the principles of the antiseptic doctrine in 1867, and had continued to accumulate evidence in its favor during the ten intervening years (1867 to 1877).

Let us remember that in 1878 to 1880 the belief in spontaneous generation was not yet dead. Many people in the world still held it with all the ancient Aristotelian credulity, and many listened with sympathy to the prejudiced and specious

surgeon, the clearest writer and teacher, the man most beloved and venerated." (J. Howe Adams. "Life of Agnew," p. 333. Philadelphia, 1892. Davis & Co.)

arguments of Pouchet and Colin at the French Academy, of Bastian in England, and Liebig in Germany, long after Pasteur had delivered the deathblow to this belief, a whole decade before, when he irrefutably demonstrated its fallacy and failure as a scientific explanation of fermentation and putrefaction. And so it was that in medicine and surgery very slow progress was made in learning how to use the words "infection" and "sepsis" in a Pasteurian and Listerian sense, that is, as synonymous with bacterial invasion, a living contagion, a transmissible, inoculable and multipliable entity amenable to all the laws that govern animate things—the *contagium vivum et animatum*—the microbe.

This does not mean that the words "infection" and "sepsis" in relation to wounds were new or unknown before the antiseptic age. The word "sepsis" had been in use since the beginning of the eighteenth century, and "antiseptic" substances had been recognized from time immemorial to designate chemical agents that were opposed to putrefaction. The pharmacopeia was indeed rich in these substances long before Lister, who, basing himself on the researches of Lemaire and Calvert, had brought carbolic acid into prominence as the chief representative of the antiseptic group.

Thus it was that during the course of my internship at the Charity Hospital we, of the staff, were quite familiar with the corrective properties of chlorinated soda, better known as Labarraque's solution, and other chlorine derivatives which played so conspicuous a part in the Carrel and Dakin treatment of wound infections during the first World War. Iodine in alcoholic or aqueous solution, potassium permanganate, the coal-tar solution popularly known as Goudron Bobeuf, zinc chloride, Peruvian balsam, Friar's balsam (tincture of benzoin compound), alcohol, spirits of camphor, glycerin, tincture of arnica, nitrate of silver, turpentine, calomel powder, yellow bichloride wash, black calomel wash, iodoform, and innumerable other aromatic alcoholic tinctures including aromatic wine,

"vin aromatique" of the French Codex, played an important rôle in the "mundification" (disinfection) and deodorization of wounds and infected areas, long before their value as germicides entered into the calculations of their prescribers. Nor were the ubiquitous hot flaxseed poultices forgotten as the ever faithful arm of our fathers in days of purulent trouble. But carbolic acid held the spotlight in the antiseptic scenario until the early nineties, when it was temporarily dethroned by the introduction of the bichloride of mercury (corrosive sublimate). This had been shown in the laboratories of Robert Koch, in Berlin, to be infinitely more germicidal by the tests of the laboratory. However, after causing very considerable mischief the corrosive sublimate failed to hold its supremacy in the clinic by the loss of bactericidal efficiency in the presence of coagulable serum and in the purulent secretions of the wounds, despite the efforts of Dr. E. Laplace, of our staff, and a pupil of Koch, in New Orleans, to maintain its laboratory efficiency by the addition of tartaric acid to the sublimate solutions. Fortunately for the hands of the surgeons, the personnel of the operating room and the skin and tissues of the patients, the need of this most irritating, toxic and discoloring agent ceased with the advent of heat sterilization and the rubber gloves or "boiled hand."

In the transition between the old septic and the new antiseptic period there were many modes of treating wounds, almost as many as there were senior surgeons on the staff. These variations were most notable in the treatment of compound fractures, lacerated and incised wounds and especially amputations, which were the most frequent major performances at a time when the field of surgery was much restricted in its indications and limitations (1877 to 1880).

Notwithstanding the seeming indifference or reluctance to adopt the typical Listerian dressing, there were certain prominent features of the antiseptic ritual which found general acceptance, even when the

doctrine itself was subject to doubt and criticism. These were:

(1) The use of carbolic acid as the preferred antiseptic.

(2) The revival of drainage with Chassaignac's rubber tube in wounds and in closed amputations, leaving the stumps open and unclosed.

(3) The gradual adoption of the buried, short cut, carbolated ligatures, preferably Lister's catgut or silk. But even this marvelous improvement in technic was slow in coming, for, in 1878 and 1879, I saw a number of amputation stumps from which long ligatures dangled, waiting to ripen in pus to drop off.

(4) At an amputation it was the most frequent practice to irrigate the wound with a 5 per cent carbolic solution, then insert the rubber drains and suture the flaps, leaving large intervals between the sutures, after which adhesive strips were applied to support the whole stump, while compressing with gentle pressure to avoid dead spaces.

(5) The stump and limb were wrapped in cotton batting (later sterilized absorbent cotton was used) and bandaged with the wide heavy cotton or linen rollers of that period.

While this mode of treatment gradually became part of the routine management, the procedure was something of a compromise with the early Listerian ritual in which many of the minor features were missing. It was virtually the same dressing which Lister himself had modified from Syme, his father-in-law, in Edinburgh, long before Lister had arrived at the conclusion that infection was the assault of a bacterial invasion.

As relics of the pre-antiseptic period, various methods of dressing and treating stumps were still in evidence before 1880. These varied considerably, according to the school in which the surgeons had been trained. The surgeons who were graduates of American schools were largely inspired by the American texts of Ashurst, Gross, Hamilton and Agnew, with a funda-

mental leaning toward British traditions (Astley Cooper, Erichsen, Bell, Paget, etc.). Those of French origin still held allegiance to the great Parisian masters, Dupuytren, Velpeau, Lisfranc, Broca, Nelaton; while the few Germans swore by Von Graefe, Langenbeck, Volkmann and Billroth.

As a result of this international medley, a number of methods were devised to protect the amputations from infection or to combat it when it occurred. These procedures if catalogued would embrace over twenty to twenty-five designated titles, and can be generally classed under two heads:

A. Methods which aimed at a free contact of the open stump with the air, with or without approximation of the flaps, kept wet or dry according to the circumstances. The open or dry methods were advocated in Britain by Teale, of Leeds, Humphrey, of Oxford, Stimpson, of Edinburgh (1860), and with some modifications by Volkmann, Thiersch, Nussbaum and Billroth (1855 to 1876) before their conversion to Listerism.

(1) A typical dressing of the *open dry* type was that practised systematically by Dr. James R. Wood, of New York, which is graphically described by Dr. Frederick Denis, his devoted intern (1876):

"After the limb has been amputated, the flaps are not even coaptated, but left entirely open. A pillow of oakum is placed under the stump, which is allowed to rest upon this support until the wound is nearly healed. A small piece of gauze is placed over the contour of the stump and a cradle over the limb, so as to avoid contact with the clothing. This is all the dressing that is employed; no sutures are used except in lateral skin flap methods, no adhesive plaster, no oil silk, no bandage. No dry charpie is stuffed into the wound, no fenestrated compresses are placed between the flaps; in other words, the stump is left entirely alone, naked, just as the surgeon made it in his amputation. . . . As the wound drains freely, it is irrigated at frequent intervals with carbolic solution, after which Balsam of Peru (which makes a fine stimulating application) is poured over the granulating surface. When suppuration has subsided the flaps are gradually approximated by strips of adhesive plaster."

(2) In the *wet division* of the open methods, the most prominent was the "cold water dressing" of Robert Liston, used in bad septic cases as late as 1885 and later. This consisted in holding the stump on a rubber covered pillow, keeping it constantly wet by a drip of cold water, (plain or medicated) falling on a thin gauze cloth from an overhanging receptacle, the water draining by a gutter to a bucket on the floor.

(3) In this group also was the "simple open wet dressing" of Prof. John Ashurst, of Philadelphia (1870 to 1885), in which the sutured stump was drained with rubber tubing and kept wet by loose surface dressings soaked in *laudanum*, substituting this by alcohol at the end of forty-eight hours.

(4) An extension of the *open wet method* was that advocated by Langenbeck, in Germany, Lefort and Verneuil, in France, and Hamilton, in New York, which consisted in keeping the patient himself immersed, with his open undressed stump, in a tub with flowing plain or medicated water. This was carried out on the same principle as the Hebra continued tub baths utilized to this day in the Austrian and German dermatological clinics.

B. Methods which aimed at the total exclusion of air from the stump, under the impression or belief that the infection, whatever it was, was transmitted through the air,¹ in manifest contradiction to the principles held by advocates of Class A.

(1) Perhaps the most typical of these was the method to be described later, the "*pansement ouaté*" of Alphonse Guerin, with which I was most familiar, as I had seen it applied at the Charity Hospital.

(2) Other methods which were remark-

able because of the devices used to exclude air from the stump were: the "pneumatic occlusion" of Jules Guerin (1865); the "incubation method" of Jules Guyot; the "pneumatic aspiration" method of Maisonneuve, which aimed at the constant aspiration of air and secretions; the dry closed covered dressing, with drainage, practised by Syme and Lister before Pasteur's discoveries (1850 to 1860).

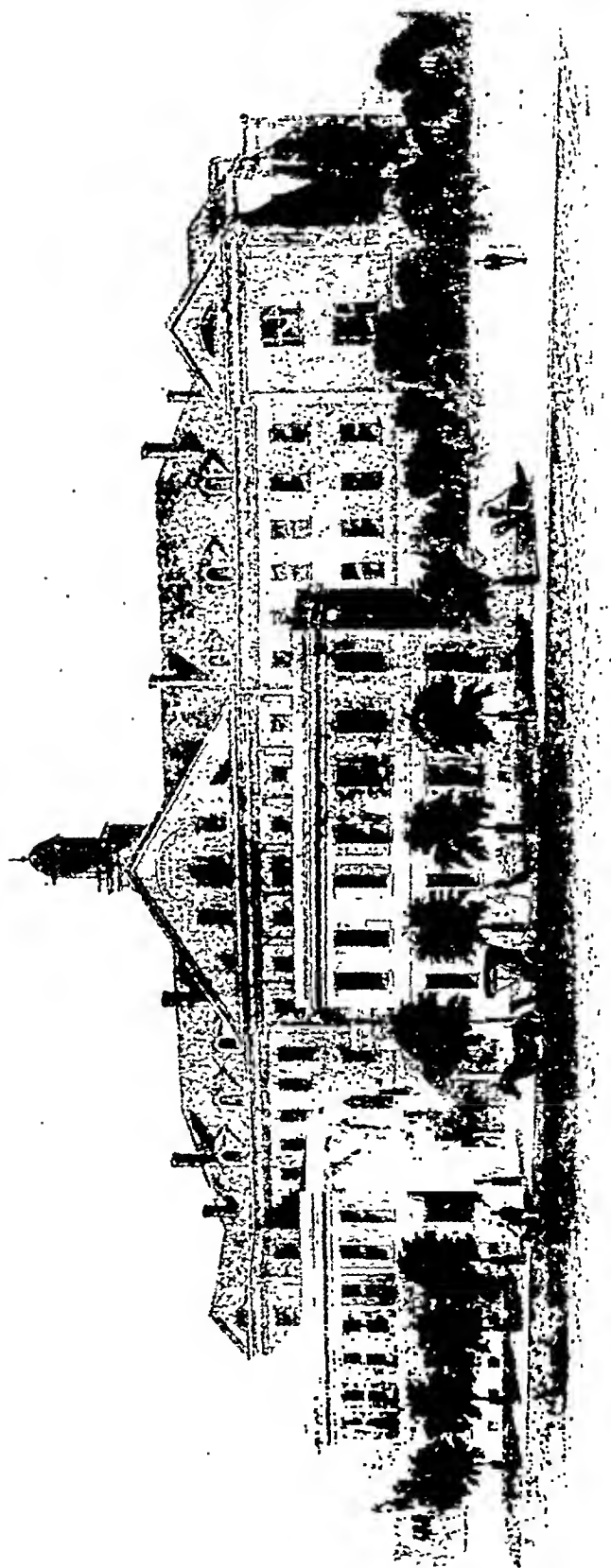
(3) Among others were the "Bordeaux method," a compromise between the Guerin and Lister methods (1864); the "earth pack" dressing of Addinell Hewson, of Philadelphia (1872); the coagulating "perchloride of iron dressing" of the open stump of Bourgade, of Clermont Ferrand, France, which created with the perchloride a "tough leathery cuirass of necrotic tissue which completely isolated the subjacent tissues from the influence of the contaminating air and other surrounding agents. This mass was detached slowly after the sixth or tenth day, and in becoming detached, left a surface covered with healthy granulations. The wound was then dressed with aromatic wine and the flaps brought together to induce union by second intention."

This multitude of dressings and their variants, of which the titles just referred to are only samples, and in which the advocate of each mode deplored the great mortality of amputations in the hands of other surgeons and confidently put forward his own method as superior, which, by his own experience, he had proved best—showed by the complexity of methods and their contradictory principles and ideas—how, in ignorance of the essential causative factor of infection, the surgeons of the pre-antiseptic period, in despair at the fearful and prohibitive mortality of their operations, sought frantically anywhere and everywhere, for some mode of relief.

ALPHONSE GUERIN AND THE "PANSEMENT OUATÉ"

Of these international and pre-Listerian methods, I was most impressed by the

¹ The notion of protecting a wound from infection by excluding atmospheric air is an old one. The germ of the idea is found in a treatise on wounds by Cesar Magatus, a Franciscan monk and professor at Ferrara, who lived from 1579 to 1647, but the first practical application of the method in modern times is attributable to Chassignae, who, in connection with his system of tubular drainage (1858) recommended that the wound be closely covered with strips of plaster in order to exclude it completely from the air. (Ashurst. International Encyclopedia, vol. 1, p. 595, 1881.)



The Original Charity Hospital of Louisiana, at New Orleans

closed method of treating amputation stumps, which had been introduced by Dr. Yves Lemonnier, a distinguished Louisianian of French descent, who, on returning from Paris in the early seventies had brought with him, and applied for the first time, the closed, cotton-pack dressing of amputation stumps known in France as the "*pansement ouaté*" of Alphonse Guerin and which we, the interns, designated as "Lemonnier's cotton bale dressing." Though Guerin and his "*pansement ouaté*" have long since been forgotten, even by the few men who have survived the period of our internship, I feel justified in lingering over it as an episode of particular significance as a precursor of Listerian practice, as well as on my own account because of my vivid recollections of the genial surgeon who sponsored it and of the benefits that seemed to accrue from the application of this method, despite the paradox of its very disagreeable olfactory offensiveness. The memory of this dressing has also been very sharply revived by its analogies to the closed plaster of Paris method of J. Winnett Orr, of Lincoln, Nebraska, applied by Trueta and the Spanish surgeons on the Catalanian war front in the late civil war in Spain.

Guerin believed that septic infection in wounds was caused by contact with the atmospheric air, which brought to the wound an air-borne but unknown poison or miasm which, possibly acting as a ferment, caused inflammation and suppuration. He believed that if air could be excluded from a surgical wound, as in an amputation, septic infection would be avoided. He justified his view by comparing the benign behavior of a simple fracture in which the air was excluded from the seat of injury, and the disasters of compound fracture, also the effect of opening cold abscesses which were painless and apyretic as long as air was not allowed to enter the abscess cavity; and he also pointed to the comparative innocuousness of the subcutaneous operations of tenotomy in orthopedic surgery, with the formidable consequences of the

open section of the same tendons and fascia. Therefore, he advocated the making of valvular incisions in draining pleural effusions and fluid collections in joints, which allowed drainage without admitting air into the cavity; also in doing subcutaneous osteotomy for bone deformities, etc.

Proceeding with this idea of preventing infection by the exclusion of air, he devised his subsequently famous cotton pack dressing which he used to special advantage in the treatment of amputation stumps of the lower extremity. After the amputation, preferably of the circular type, he made no attempt to approximate the flaps, but packed the whole wound with raw cotton wool so that the secretions could soak into the pack without impediment. After firmly packing the cavity of the stump or the space between the flaps, the stump and the entire limb was immobilized by enveloping it in a huge cotton wrap or covering made by many successive layers of cotton batting, all bound and held snugly together by wide and immobilizing bandages. This dressing, once applied, was not disturbed at least for two or three weeks. In the meantime, the discharges slowly permeated the dressings and became extremely foul and offensive, so that by the time they were removed they had become an intolerable nuisance.¹ Strange to say, when the dressings were removed and the great magma of pus and other decomposing material had been washed off, the raw surfaces of the stump presented a rosy, granular, and seemingly perfectly healthy appearance. Healing had progressed in a perfectly normal course despite the abundance of pus and saprophytic emanations. Under these conditions, the flaps were then brought together and held in contact with adhesive

¹ It was this most disagreeable feature that made the Guerin dressing highly unpopular and restricted its use in the wards of its chief advocate (Dr. Lemonnier) who seemed to gloat with satisfaction at the discomfort of his critics whenever they came to him with complaints about the odor of his patients, pointing to their comfort and feverlessness and their healthy, painless and healing wounds, when their dressings were changed and the secretions were washed away.

strips or interrupted sutures until complete union and cicatrization had taken place, the stump being again immobilized in a copious cotton dressing, which was cheaper and more available in Louisiana than in any other part of the world. The most notable feature of this cure was that, despite its stench and offensiveness after the dressing had been on for over two or three weeks, the patient recovered without any of the usual local and systemic complications of rival methods.

The reasons for the success of this method according to the author were: (1) that it kept away atmospheric contamination during the process of healing; (2) it allowed free drainage; (3) it kept the wound free from irritating washes and disturbing manipulations; and (4) it kept the amputated limb at rest while healing was going on. And that is precisely the experience that was renewed by the Spanish surgeons during the late civil war by the practice of the *closed plaster of Paris method*, in dealing with compound fractures and septic war wounds, which, despite its offensiveness, has yielded such surprisingly favorable results.

As the story of Alphonse Guérin and his method has some distinct bearings on the mode of treatment that preceded the adoption of the Listerian principles, it will not be inappropriate to make some reference to his personal career and to the fate of his method. Guérin was born at Ploermel, in Brittany, in 1816, and died in 1894, at the age of 78. He was elected surgeon to the hospitals of Paris in 1850. Three years previously he had advanced his theory of wound sepsis as dependent wholly upon "miasmatic" contamination of unknown origin through the atmosphere. In 1871, he first applied the occlusive dressing to amputations, which bore his name. In 1872, the members of the French national society of surgery were dumbfounded when he reported that out of thirty-four thigh amputations, nineteen had been saved by his method.

At that time septic infection in amputations, at the thigh, was regarded as almost

inevitably fatal, and the military experience of the surgeons of the Franco-Prussian War (1870 to 1871) only too tragically confirmed this fatalistic prognosis. The post-operative mortality during that war was so frightful that the ablest surgeons in Paris felt compelled to close their wards. Trelat definitely quit all his work at the St. Louis Hospital after losing practically all his wounded. Gosselin, Verneuil and Nelaton, likewise dismayed by their mortality, hurriedly gave up their services. And the same thing happened in Germany, where Volkmann, Nussbaum, Thiersch and others had to stop operating for the same reason that prevailed in France and in other countries. It was during these tragic hours, when death seemed to stalk in the footsteps of the surgeon as if to complete the deadliness of warfare, that Alphonse Guérin came unexpectedly on the scene with his strange dressing, to bring hope and confidence to his disheartened colleagues.

It was about this time, during the siege of Paris (1870 to 1871), that Nelaton, at the Grand Hotel, which had been converted into a hospital, in despair at the seeming failure of surgery to stem the tide of infection and disaster, declared that "whoever triumphs over purulent or septic infection deserved a statue of solid gold."

While Guérin's simple "cotton bale dressing" was not based on a clear or demonstrable scientific principle apart from its definite aim at the exclusion of aerial contamination, its practical application constituted a real advance. It is not surprising, therefore, that for two years after the Franco-Prussian War Guérin enjoyed a just reputation as master of surgery in Paris, and that his office became the *rendezvous* for a continuous parade of students and surgeons who came to observe and learn from him a mode of treatment which, despite its serious defects, proved superior to all others. The reputation of Guérin, like that of Nelaton,¹ his con-

¹ Nelaton's fame had spread especially in France and Italy because of the porcelain probe that bears his name. With his porcelain probe, devised for the purpose, he had discovered the long hidden bullet in Garibaldi's leg, at a time when a number of eminent surgeons had

temporary, had travelled a long way beyond the national boundaries, but by a different route.

Besides his skill, he was quick and quite witty, as is shown by the following anecdotes told of him. On one occasion Guerin was called to Rome to attend Pope Pius IX, who was suffering from an ulcer of the leg, which he cured when other eminent surgeons who had preceded him had failed. The Pope in thanking him said that, in his opinion, he, Guerin, was "the greatest surgeon in the world," to which Guerin replied, "I bow in thankfulness to the judgment of your Holiness, which I accept unquestioningly, since it is infallible." On another occasion, after the great surgeon had auscultated the chest of the supreme pontiff, he said, "I shall be very careful, your Holiness, when I return to France, to let no one know that my hand has rested on your breast, for if I did, they would soon cut off my ears to make relics of them." (Fourmestraux.)

MORITZ SCHUPPERT—PIONEER IN ANTISEPTIC SURGERY IN AMERICA

When Lister came to the United States in 1876, to preside at the International Medical Congress held in connection with the Centennial Exposition at Philadelphia, which was ten years after his first pronouncement of the antiseptic doctrine, he was no doubt disappointed at the indifferent impression that his teachings had produced in the United States. This was even more remarkable in view of the much closer relations of the United States to England than any other country and that the Germans, whose clinics were much frequented by admiring Americans, had adopted Listerism with great enthusiasm.

The reasons why American surgeons had been so slow in subscribing to the Listerian doctrine were well stated by Professor Robert F. Weir who, writing in 1877 (*N. Y. Med. J.*, December, 1877, January, 1878) stated: "It is only lately that in America

attention has been given practically to the teachings of Lister in respect to the treatment of wounds. In fact, aside from an article by Schuppert in the *New Orleans Med. & Surg. J.*, little or nothing has appeared in our medical journals relative to the result of the so-called antiseptic method." The reasons given by Weir to account for the tardiness of American surgeons to try this mode of treatment were: (1) that the treatment, as enunciated by Mr. Lister "has been repeatedly changed in its details; (2) that it was too complicated and demanded the supervision of the surgeon himself, or, in a hospital of a carefully trained staff of assistants; (3) that many who had tried it had been unsuccessful in the cases where the essay had been made; (4) but the most weighty objection which was asserted or entertained was the positiveness of the enunciation of the germ-theory in explanation of the process of decomposition in the secretions of a wound." While this was true, there was still another reason which Dr. Weir did not mention and that was the indifference, the hostility of some of the leading British surgeons, themselves, who sought to minimize the importance of the Listerian movement at home (Nunnally, Savory, Paget, Wood, Humphrey, Spence, Callender, Bantock, and above all, Tait). But this opposition was offset later by the loyalty of Lister's pupils and associates and by the enthusiasm of the Germans, French and all the leading surgeons of the continental European countries, who ultimately recognized the merit of his labors and accorded him the homage due to one of the world's greatest benefactors.

In New Orleans (1877 to 1880) as previously stated, the faculty and the staff of the Hospital, in common with all the leading surgeons of the United States, were undecided, skeptic or frankly hostile to the method, the only exception being a German surgeon, Dr. Moritz Schuppert, graduate of the University of Marburg (1849) where he was born in 1817, who championed the cause in New Orleans. He had settled in New Orleans in the early fifties, soon rising to dis-

failed to demonstrate its presence. Of course this was long before the age of Roentgen and the x-rays.

tion as a very able operator and prolific writer, despite the short time he had to acquire a knowledge of the language. He was soon a member of the Hospital Staff, a professor in the Charity Hospital Medical School and prominent at medical meetings. Always a diligent student and omnivorous reader, he kept in touch with German literature, and it was from this source that he gathered the enthusiasm of his old friends and teachers in acclaiming the new era that had dawned in surgery with the advent of Lister and the antiseptic doctrine. In a lecture published in the *New Orleans Med. & Surg. J.* for January, 1878, Schuppert stated: "The astonishing reports which had reached me from the interior of Germany at the end of 1874, that the antiseptic treatment of wounds recommended by Lister promised to cause a revolution in surgical practice, did not permit me to rest, and the Spring of 1875 found me already on the road to visit those places where such stunning facts were reported. After my return to this city in the fall of 1875, I gave a resume of what I had absorbed in some of the most renowned hospitals of the European continent in a few lectures delivered in the amphitheatre of the Charity Hospital and reported in this Journal."

In this extensive monograph, Schuppert gives a most minute description of the antiseptic treatment, the progress it had made, especially in Germany under the leadership of Volkmann, whom he admired intensely and followed most closely; and he closes finally with a complete summary of his own experience based on his personal operations in New Orleans at the Charity Hospital in strict pursuance of the Listerian method during the period 1875 to 1878.

His summary embraces 120 miscellaneous operations including twenty-three amputations (major and minor), seventeen resections of bones and joints, two compound comminuted fractures of leg and thigh, five ligations of arteries in continuity, thirty-four cuts and stabs including larynx and pharynx, stab of chest, two

gunshot wounds of abdomen (one death), three penetrating stabs of abdomen with no deaths, altogether 120 operations, besides forty-four chronic ulcers of the leg, treated antiseptically, with a total mortality of only 4 per cent.

He describes in minute detail the antiseptic treatment in the complicated and methodical ritual-like form of the early Listerian dressings, but modified and simplified by Volkmann and later by himself after his return to New Orleans. These details I learned personally under very impressive circumstances when it was my fortune to be called, as interne, to carry out the full program of antiseptic preparation for the extirpation of an enormous ovarian cyst in a patient admitted in the summer of 1878. The chief of my service, Dr. Wm. Carson, called on Dr. Schuppert to direct and assist him in the prospective ovariectomy which was to be the first performed in the Hospital under strict antiseptic precautions. This occasion gave me an opportunity to become acquainted with that remarkable veteran of surgery and his two sons, William and Charles, both graduates of medicine, who assisted him, particularly William, the eldest, who had recently arrived from Vienna after two years of study in the surgical clinics of that great and flourishing center of medical culture.

A COMPLICATED OVARIOTOMY UNDER THE SPRAY

The patient, a white woman of 55 years, presented a huge ovarian cyst of the gigantic size now never seen, but common enough then, when tumors grew unmolested in patients living in the rural districts, like the trees of a primeval forest which has never known the aggression of the sawyer or of the lumber jack. The patient had been tapped many times and the effects of these tapplings were secondary peritoneal reactions followed by general adhesions which completely immobilized the sac. Besides, the tumor was so large that the patient, who was small, thin, and worn by pro-

longed suffering, seemed to have grown to the tumor rather than the tumor to her. "A very unpromising case" as Dr. Carson and Dr. Schuppert remarked. Under Schuppert's instructions, the patient was kept in bed and given the benefit of all the preliminary examinations and dietetic and hygienic care to fit her as much as possible for the operation. Miserable and discouraged, she begged to have something done regardless of consequences. Accordingly, a small operating room was chosen, away from the main theatre to avoid dust and an overcrowded audience. The night preceding the operation, the floors were scrubbed and covered over with sheets rinsed in a 5 per cent carbolic acid solution and the walls were also covered with sheets rinsed in the same solution. The tables for instruments and accessories were all draped in the same freshly laundered sheets which had been wrung out in the carbolic solution, the gowns of operators, assistants and nurses alone were exempt from the acid bath. The instruments, previously well scrubbed, were kept immersed in a 5 per cent carbolic solution. Large "elephant ear" marine sponges were kept immersed in the carbolic solution, ready for use in the abdomen.

The wash room was furnished with soap, brushes and a 5 per cent carbolic solution for hand scrubbing and disinfection. There were no caps, no masks, no gloves, as these were unknown at that time (1878). The abdominal surface was prepared in the usual way by applying a thin poultice of green soap, to be followed by a thorough wash of the softened skin with a 5 per cent carbolic water solution, leaving a thin towel wrung out of alcohol over the abdomen until the start of the incision. The drapery of the patient was all freshly laundered.

A hypodermic of morphia was given twenty minutes before the operation and the anesthesia started with chloroform dropped over an open cone. The anesthetist was an undergraduate intern, as it was the custom to give the residents practical experience.

Finally, a large steam atomizer was started to keep a steady spray of a 5 per cent carbolic solution continuously over the operating field.¹

Schuppert often spoke of substituting thymol for carbolic acid as this was being done by Volkmann at Halle with satisfactory results, or salicylic acid which Thiersch was then trying at Liepzig. Neither of these was available at the Hospital and the classical carbolic solutions were used.

Finally, the moment for the operation had come but, despite the efforts to reduce the number of spectators they continued to squeeze in, always getting nearer the operating table in their street clothes without any overgown or other pretense of a cover to reduce the risk of contaminating the room, depending only on the spray to shield the field of the operation from air infection. As it was a hot summer day, the combined effect of the spray and the overcrowding of the small room, caused the perspiration to start freely on the forehead of the operator (Dr. C.) and his first assistant, Dr. William S., while the senior Dr. Schuppert, as director and counsellor, sat on a stool by the side of the patient with the operating field in excellent view. A nurse was kept busy from the start with a cold wet towel to wipe the perspiration which was streaming from the heads of the operators. There were then no electric fans, no air conditioning apparatus such as now makes operating more comfortable and even enjoyable, only palmetto fans which were forbidden for obvious reasons. The recollection of that hot, stuffy room under the sky lights on a bright summer day makes me realize the enormous advantage and comfort of modern air conditioned operating rooms, with no spectators in the way, and the powerful shadowless electric lights which make the skylights, and the placing of operating rooms on the top floors of the buildings, absolutely unnecessary.

¹ While these preparations were going on, my clothing became so permeated with the odor of carbolic acid that my classmates used to tease me by calling me Lister—"Mr. Lister, when will you serve that carbol lemonade?"

Going back to the operation and the anxious operators, the pathology in the peritoneum was found even worse than anticipated, for the cyst, with thickened walls, contained over six quarts of dark discolored serum, and the cyst was uniformly fixed and bound down by adhesions to the abdominal wall and intestines. In fact, it was only by extreme caution that an adherent coil attached to the abdominal wall immediately under the line of incision escaped injury. After working with great care for over an hour to detach the densely adherent bowels, the cyst was mobilized sufficiently to exteriorize two-thirds of the sac, leaving the last segment sutured to the abdominal incision where it could drain externally through a rubber tube. In the course of the detachment of the bowel from the cyst, the intestinal walls were so thin in places that they had to be protected by a reinforcing line of sutures, as in some places it was not certain that some gas had not escaped from minute tears. The abdominal incision had to be very much enlarged to deal with the adhesions, requiring much time to close it with the through and through silver wire sutures which were in favor at that time.

In the meantime, the carbolic spray was kept going, much of the atomized vapor settling on the incision and peritoneal cavity. Of course the wide retraction of the abdominal incision with the powerful automatic retractors of the present day were missing and the systematic dressing of the edges of the incision was not yet a part of the technic. The large, soft, "elephant ear," marine sponges did good service, and they would even now be of inestimable value were it possible to sterilize them by heat once they have served in the abdominal cavity.

Fine carbolized silk was used for the intestinal sutures and ligatures but the profusion of intestinal clamps and hemostats which we now find so indispensable in present day practice were not there. It is really remarkable, as I think retrospectively, how much good work was done by

the two relatively young operators who were tackling, with no previous experience in the abdomen, one of the most formidable surgical problems imaginable, at that time. I was therefore not surprised when I heard Dr. William S. say, in a low voice, "Carson, this is terrible; it is almost inviting the patient to be present at her own autopsy."

The operation had to be hurried in its last stages, as the patient was showing signs of collapse. The abdominal incision was covered with a layer of Lister's protective, parafined gauze and several layers of superimposed carbolated cotton in compact gauze bags were laid over the abdomen, which had retracted into a deep hollow, lined with relaxed skin folds. The dressing was held by strips of adhesive (diachylon) plaster and a snug abdominal binder.

Clinical sphygomanometry was still unborn, but this was not necessary to tell that the patient was suffering from shock and exhaustion. Oxygen was not then in use or available, nor intravenous infusion of saline or dextrose, and, much less blood transfusion.

Adrenalin, ephedrin and pituitrin had not yet appeared on the horizon of surgical therapy. All that could be done was to put the patient to bed, warm her with hot water cans (no electric pads then) and give camphor oil and caffein and small doses of strychnia, digitalis, atropin and morphia by needle, with a pint of hot coffee given slowly by rectum (that was long before Murphy's proctoclysis had been introduced as the classic aftermath of every abdominal operation).

Fortunately, the patient rallied for the first two days and gave promise of recovery; but, unfortunately, nephritis set in with continued vomiting (not of peritoneal origin, but uremic) and progressive oliguria and, finally, total anuria, edema of the lungs, coma and death on the sixth day. To what extent the prolonged contact of the carbolic spray had to do with the suppression of the renal function, is not certain, but the toxic effect of the carbolic spray on the

kidneys (carboloria), in prolonged operations over large peritoneal and raw surfaces had been sufficiently demonstrated to make the substitute of other less toxic antiseptics desirable. This objection with other reasons, well established by Volkmann and Thiersch, finally led to the abandonment of the spray as an obligate part of the Listerian ritual, by Lister himself, in 1887.

The history of this patient also offers a notable contrast between the powerful postoperative therapy of the present and the scant resources of fifty years ago.

Looking back to those anxious days and nights passed at the bedside of this unfortunate woman, I can imagine how much greater the chance of saving her life if we had had available donors for blood transfusion or a knowledge of the continued intravenous dextrose and salt drip, medicated systematically with adrenalin, and other cardiovascular stimulants as indicated. Besides, what an enormous advantage the duodenal tube for gastroduodenal syphonage would have been as a check to the vomiting; and again, the aid of a constant stream of oxygen by nasal intubation would have contributed so helpfully to the whole plan of relief.

A LONG DELAYED RECOGNITION OF MERIT

In connection with the early history of Listerism in the United States, I believe there can be no question that Schuppert was its first apostle in America. As previously stated, he visited Volkmann and the German clinics expressly to familiarize himself with the method so that he might apply it at once on his return to America that year. He utilized his surgical clinic at the Charity Hospital exclusively for the practice of antiseptic surgery and was promptly recognized as its ablest authority and expert. He was also the first in Louisiana, as Dr. W. Carson's guide and consultant, to direct all the details of the antiseptic technic in the first ovariectomy performed at the Charity Hospital by this method. In this he preceded Dr. Ernest

Lewis (the father of gynecology in Louisiana) who extirpated very successfully a monstrous giant tumor of the ovary estimated to weigh with its fluid content, sixty-five pounds (!). This operation was performed under rigorous Listerian rules; Schuppert also preceded another operation, the third in the same year (1878) in which Dr. S. G. Choppin, an associate and great friend of Schuppert, did a successful ovariectomy for a solid growth, of moderate size. Unfortunately, the Hospital records of all these cases were lost sometime in the early nineties when a fire in the attic of the Hospital destroyed a great collection of ward histories, including that of the patient just described, without leaving a record of the precise date it was performed, except that it (Schuppert-Carson patient) antedated all the others operated that year (1878). No report of the operations performed by Dr. Lewis and Dr. Choppin were ever published except for a brief account given by Dr. Lewis in his *Reminiscences*. (*New Orleans Med. & Surg. J.*, pp. 744-766, April, 24, 1922.)

Despite the fine example set by Schuppert, the Listerian technic made slow progress in Louisiana and elsewhere in the United States. So learned and progressive a surgeon as Ashurst, of Philadelphia, in the second edition of his textbook of Surgery, which was the standard in all American schools for over a quarter of a century, said, in 1878, "the alleged superiority of the antiseptic method has not yet been demonstrated." And that opinion was expressed, let us remember, eleven years after Lister had issued his first announcement of the antiseptic doctrine. Professor Ashurst, sixteen years later, in his sixth edition (1895), —[fifteen years after my graduation in 1880]—wrote approvingly of the Listerian practice, but gave his blessing in a cautious way. In this he said, "I feel compelled to say that, while I cannot subscribe to the extravagant laudations which this plan received at the hands of his more enthusiastic advocates, I believe that, when used with judgment and diluted with common

sense, it is capable of affording valuable aid." And this was indeed high praise when compared with the violent diatribes that Lawson Tait and his followers hurled against Lister and his gospel.

It is doubtful that the Listerian dressing in full ritual, of the early period, was ever applied in New Orleans outside of Schuppert's clinic. But surgical cleanliness based upon a clear conception of its germicidal purpose, with special regard to the pre-operative care of the surgeon's hands and the shaving, scrubbing and washing of the field of the operation, followed by carbolated compresses, was beginning to tell for the betterment of the surgical and obstetrical services. But even in the eighties, *noli me tangere* was written large on the head, chest and abdomen, and their contained organs were still held as in sanctuaries which no one dared to open with unhallowed hands. Surgery was still largely restricted to such interventions in the visceral cavities which were made compulsory by accidental injuries and imperative vital indications. Apart from fractures, dislocations, and the usual accidents that are common to metropolitan and industrial life, the conditions for surgical treatment did not constitute more than 15 or 20 per cent of the indications that call for surgery at the present time. Peritonitis was treated as a disease without regard to its cause. It was a notable event when Homans, of Boston, on May 4, 1886, actually opened, for the first time an intraperitoneal abscess without identifying the appendix. The mere fact that a nonencysted acute intraperitoneal abscess, presumably caused by a suppurating appendix, had been intentionally sought for and opened by an abdominal incision, was regarded as a very audacious procedure (Med. Rec., New York, May 1, 1886). Operations for hernia were limited strictly to the relief of the strangulation. No laparotomies for perforating wounds of the abdomen were performed, and opium was the only and universal remedy.

The Charity Hospital of New Orleans, a state institution which dates its existence

from 1832, showed a record of only 172 operations in 5,300 admissions during the year 1881, or a little over 3.2 per cent; and of these, seventy-two were amputations, thirty-two incisions for abscess, three ligations of arteries, eighteen extractions of projectiles, and one single laparotomy! In other words, 96 per cent of the cases admitted were medical and 4 per cent were surgical.

In 1890, the year when the American Journal of Surgery was founded, there were 6,083 admissions, including 291 important operations. In other words, 95 per cent admissions were medical and 4.7 per cent surgical; evidently no very great progress had yet been accomplished in the expansion of surgery.

But now in 1940, after the lapse of a senicentury of history, we find that out of 58,889 admissions for the year ending July 1, 1939, 23,473 were surgical. In other words, the treatment of disease in this hospital, which in 1881 had been a little over 3 per cent surgical, in 1940 has become 40 per cent surgical.

The experience of the Charity Hospital in New Orleans is only one example of the effect that the Listerian revolution created in hospital practice throughout the world. But this progress as we have indicated was accomplished gradually, very slowly. The year 1890, however, marked the most rapid advance. Every year after that recorded some new territory invaded, some new operation or new technical acquisition that improved and added to the dominion and security of surgical operations, especially those of the abdominal and other visceral cavities. By the end of the nineteenth century (1890 to 1900) surgeons had less dread of opening the abdominal cavity than their predecessors in performing even a minor amputation of the extremities. Abdominal surgery, especially that of the pelvic cavity, had gone so far in dealing with ovaries, uterus and adnexa, that in 1895, Dr. Chadwick, of Boston, president of the American Gynecological Association, felt it incumbent, in his presidential ad-

dress, to protest in the name of gynecology against the great excesses that were being committed in the female generative organs.

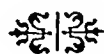
STEAM AND THE "BOILED HAND" SPEED SURGERY TO NEW CONQUESTS

By 1895, the Listerian ritual had been divested of almost all its formulas, and dry heat and steam sterilization had largely replaced chemical sterilization, except in the preparation of the skin and operating field which could not be subjected to sterilization by heat. At the same time rubber gloves introduced by Halsted, in 1890, had created the equivalent of the "boiled hand" which not only gave infinitely greater security to the manipulations of surgery, but protected surgeons' hands from the harshness and injurious effects of the chemical antiseptics of all sorts, which had been ineffectually tried in infinite ways before the boilable rubber gloves were introduced. All that remained, seemingly, as a source of infection in surgical wounds was the possibility of atmospheric contamination, which had been long since relegated to a secondary plane as a negligible

quantity when the spray was abandoned as unnecessary, even by Lister himself. In this way the antiseptic practice of Lister by chemical sterilization had undergone radical modifications, while still retaining the integrity of its fundamental principles, namely, the prevention of infection in clean, uncontaminated surgical wounds and the sterilization of wounds already contaminated or infected, in which chemical sterilization still had its application. Antisepsis had yielded to asepsis, a word which Lister himself had coined to indicate a state free from sepsis or infection.

Roentgen's discovery of the x-rays came in 1895-1896 to inaugurate a new agent of transcendent importance for the development of surgery. By illuminating the body, diagnosis was marvelously simplified and immediately the indications for surgery prodigiously multiplied.

Roentgenology supplemented by the constantly growing collaboration of the physiological and biochemical laboratories, all combined to so rejuvenate and transform the face of surgery that it was no longer recognizable in the light of its ancient portraiture.



THE EVOLUTION OF MODERN SURGERY*

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WHERE the love of man is, there also is love of this Art."

By way of introduction we might inquire what we mean by modern surgery and who was the first modern surgeon. Certainly, surgery reached a high degree of technical precision, dexterity and speed before anesthesia was discovered or Lister came upon the scene. The treatises on dislocations, on fractures or on wounds of the head of the Hippocratic collection are essentially modern.¹

Medicine is the reflection of the religion, the culture, the politics and always the economic condition of the time. One could write the story of philosophy, of physics, of chemistry or the political economy of a period from the biographies of the personalities of medicine. It is historically an arresting fact² that the three periods of the greatest activity of mankind have been those associated with a phenomenal increase in intellectual and scientific development as well as the expansion in politics, geographical discovery and economic wealth. The crowing age of Greece with its liberal mind and pure reason was founded upon a despotism of slavery. The Renaissance with its revolt against authority and tradition was built upon the wealth of the Indies after Columbus, Cortes and Pizarro. The nineteenth century with its science and machine power was to introduce the industrial revolution and to develop the huge population concentration of the city and mass production. The industrial age was to affect medicine in many diverse ways.

Two lines of development became evident. The first development was to be distinguished for inventions and discoveries in

physics and chemistry, with the founding of bacteriology, physiology and pathology as new disciplines, with the rise of experimental medicine and comparative anatomy and more recently the complete dominance of therapy by synthetic chemistry—medicine chemurgic.³ The second development was to concern itself with medical organization for social services;⁴ the rise of medical societies, health departments, school medical service, industrial medicine, workmen's compensation insurance and finally a hybrid protegee—medical economics. One may pause and wonder whether medical economics and state medicine may not be suppressing the individual and creative minds of our profession. The medical mind is sufficiently egalitarian to want the benefits of modern medicine extended to all our population but at the same time is very reluctant to destroy the individual creative spirit of the physician by a compulsive conformity to political authority or bureaucratic standards of medical service.

To say that surgical progress is the result of a collective mind working through the centuries is to oversimplify the subject. Yet the analytic historian is tempted to divide time into separate epochs and to ascribe common characteristics to each era. In Greece and Alexandria, for example, medicine and surgery were one, springing from the obscurity of pagan and temple medicine and becoming rational medicine under Hellenic influences. The evolution of modern surgery was the result of a profound change in mental and social outlook. Surgery began to be modern when certain types of mind began to break with authority and to think in terms of individual creative effort.⁶

* The John Chalmers Da Costa Oration, Philadelphia County Medical Society, Philadelphia, Pennsylvania, April 10, 1940.

Greek medicine was founded upon the ability to observe and to record medical facts—"the collation of experience from various sources and obtained by various methods."¹ Hippocrates (460-370 B.C.) showed that diagnosis could be accurate, treatment logical and prognosis definite. The heritage of Greek medicine was to be destroyed by conquest and only fragments were to be preserved in commentaries by Arabian translators of the Nestorian translations of the Greek medical books. The thousand years of medievalism were to mould the mind into a compulsive uniformity with its lack of intellectual curiosity, and clinical observation was destroyed by reverence for tradition and authority. A single universal power—church or empire—was to sanction all thought and destroy all initiative. One of the unhappy results was a complete divorcement of medicine and surgery, a separation that has unhappily continued to this day.⁷

Science depends on intellectual curiosity and individual research and with the courage to break with authority and tradition. From the shadows and twilight of the medieval period was to emerge the "tremendous universal genius," Leonardo da Vinci (1452-1518), "the incarnation of the true spirit of the Renaissance."² From his practical and utilitarian mind was to come a rebirth of intellectual interest, a rediscovery of the experimental method of Hippocratic medicine. Da Vinci was the first modern architect of scientific progress. His varied research in all fields of knowledge, his dissection of the human body with his incomparable drawings were to anticipate a new science of human anatomy, a necessary prelude to modern surgery.

Eight years (1526) after the death of Leonardo, when there was that strange combination of revolt, learning and charlatanism, Paracelsus would dramatize in Basle the revolt from medieval authority by burning the sacred volumes of Galen, Avicenna and Averroes. "Follow me," he cried, "not I, you!" New disciplines in science were being initiated; an era of fact-

finding and research was at hand. The mind of the Renaissance had replaced the medieval.

A pleasant exercise of the intelligence is to discuss an epoch as a fixed point of time. One of the most impressive passages in the "Decline and Fall of the Roman Empire" is employed by Gibbon with striking effect:

"If a man were called to fix the period in the history of the world, during which the condition of the human race was most happy and prosperous, he would without hesitation, name that which elapsed from the death of Domitian to the accession of Commodus."¹⁰

Using the distinguished historian as an example we may predicate that if one were called to fix the period that marked the separation from ancient medical practice to modern he would select 1543. In that year were published two books, both by physicians, that changed the entire scientific thought of the world. The first by Nicholas Copernicus (1473-1543), "On the Revolutions of the Celestial Spheres," and the second by Andreas Vesalius (1514-1564), "The Fabric of the Human Body." The former was to change completely our knowledge of the heavens and to remove the earth from the center of the universe.¹ The latter was to revolutionize traditional medicine and destroy the authority of Galen. It was to be the real foundation of modern anatomy and the first great scientific contribution of modern times.

Ambroise Paré (1510-1590), the first modern surgeon, was thirty-three years of age when the masterpiece of Vesalius was published. Alone he stands as an original inventive genius. He believed, however, that the plague came by Divine will, that spontaneous generation was a fact for he had seen maggots grow in war wounds; he also had faith in the royal touch for the King's evil. But Paré had a modern mind and many of his ideas have been incorporated into modern surgical practice.⁸ Two discoveries are certainly to his credit: the first, that gunshot wounds were not poisonous and that they should not be treated

with scalding hot oil, or amputations treated with red hot, soldering irons; the second discovery, somewhat less secure, was the use of the ligature in amputations for the control of hemorrhage. The ligature for the control of bleeding in wounds was as old as history. It was used for stanching blood in Greek and Roman surgery. Galen bought his ligatures "celtic linen thread in the Via Sacra between the Temple of Rome and the Forum."⁷ Paré recommended good threads, two together—"bon fil qui soit en double"—and also devised a catch forceps very similar to our modern hemostats. He was a God-fearing man, with strong lapses into superstitious practices but withal an independent thinker. "You will have to render an account not to the ancients," says Paré, "but to God for your humanity and skill." In his "Journeys in Diverse Places" he describes how Captain le Rat at the Pass of Suze en route to Turin received an arquebus shot in his right ankle and fell to the ground exclaiming, "Now they have got the rat." Paré laconically remarked "I dressed him and God healed him."⁸

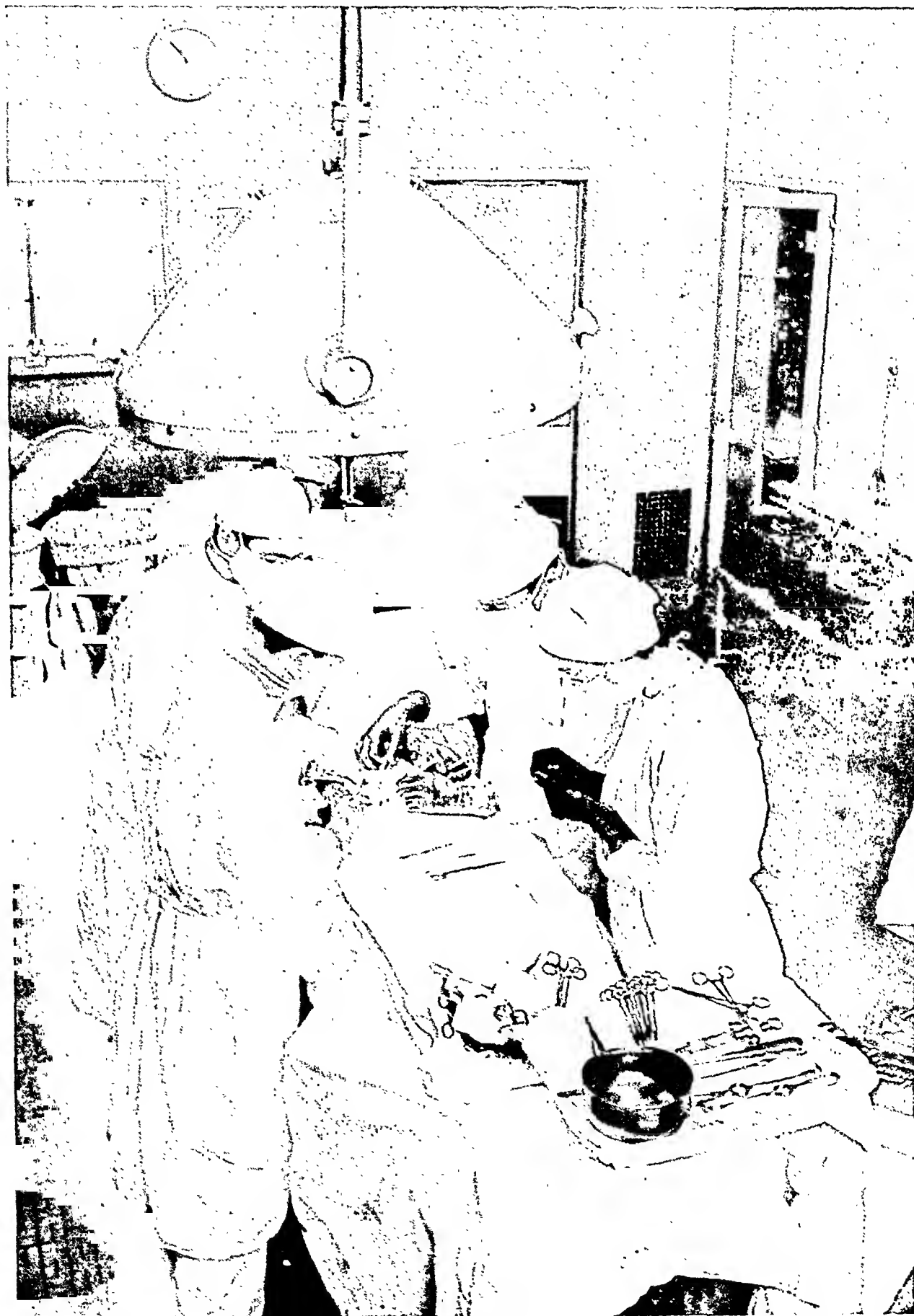
From the Greeks medicine derived two great contributions: a man and a method. In a similar sense modern surgery inherited from Paré the picture of a splendid humanitarianism and a surgical method. His personal influence must have been tremendous both with royalty and the soldiers. It is recorded that in October, 1552, when Charles v laid siege to Metz which was defended by the Duke of Guise, Paré entered Metz December 8, 1552. Guise presented him on the ramparts to all the soldiers. "We shall not die," they exclaimed, "even though wounded, Paré is among us."¹¹ His attainments as a clinician are attested by a modern critic of great ability. "Put Ambroise on one side of a patient's bed and a surgeon of our own day, single handed on the other and you will not find the balance of insight on practicality against Ambroise."¹²

Paré at sixty-five could see very little future for surgery. "God is my witness, and

men are not ignorant of it, that I have labored more than forty years to throw light on the art of surgery and bring it to perfection. And in this labor I have striven so hard to attain my end, that the ancients have nough wherein to excel us, save the discovery of first principles: and posterity will not be able to surpass us (be it said without malice or offence) save by some additions, such as are easily made to things already discovered."

Preceding the entrance of Paré upon the surgical stage there was a thousand years of the barber and barber-surgeons. In Greece and Alexandria medicine and surgery were one, and even in the time of Galen (130-200) there was no divorcement of surgery and medicine.⁷ The medieval mind, however, wanted some central authority, a spiritual power that was socially integrative. This centralized power would be either the church or the empire. The Koran prohibited human dissection as the Arabs believed it was unclean and unholy for human hands to mutilate the dead body. The few books that have been preserved were commentaries on porcine dissections. Even these books were fragmentary as many of the originals were lost. Thus Galenical anatomy was the sole anatomic authority until Vesalius. Henry of Mondeville expressed some doubts for he declared that God did not exhaust His creative powers in making Galen.

The practice of the barbers was accelerated when the monks were forbidden in 1092 to have beards and shaved faces became the fashion. Thus arose a group of menials or tonsors and scullery helpers, and later bath keepers who performed all sorts of odd jobs. Finally their activities were enlarged for the Council of Tours in 1163 prohibited the monks from practising incision and bleeding. The church abhorred the shedding of blood—"Ecclesia Abhorret a Sanguine." Thus surgery in the thirteenth and fourteenth centuries, with anatomy proscribed by the religion of the Arabs and blood-letting prohibited by the church, had no honor, no friends and no recognition.



A Modern Operation

The practice of surgery became a manual trade in the hands of the barbers and menials. These questionable gentlemen were bold, brazen, clever, with deft fingers, utterly unscrupulous, restricted by no code of ethics, without social responsibility and believed that blood-letting was a cure-all for every ill. They were ready to bleed patients at any and all times, for any and all conditions but always for money.¹²

There were, however, among their number some who aspired to greater things and at about the time that Paré, the son of a barber-surgeon, came upon the scene there were in Paris three definite groups dealing with medicine—the physicians, the surgeons and the barbers. The barbers and barber-surgeons were organized into a corporation of the barber-surgeons, while the surgeons were similarly organized into the confraternity of St. Come. The latter were barber-surgeons that had been admitted into the confraternity after examination and wore a square hat and a long robe and were designated the barbers or surgeons of the long robe. Medicine, however, was taught by the physicians in the Faculty of Medicine of the University of Paris and for many years there was a triangular fight among these three organizations.

Paré, barber-surgeon, legally could not be admitted to the confraternity because he could neither speak nor read Latin. He says, "I desire not to arrogate to myself that I have read Galen either in Greek or in Latin: for it did not please God to be so gracious to my youth that it should be instructed either in one tongue or in the other." However, he was surgeon to the king and a man of such prominence that after considerable sculduggery he was admitted, enrolled, registered and crowned a barber-surgeon in 1554. The confraternity at that time called itself euphemistically, "The Royal College of Surgeons of Paris."

The same story could be repeated in Great Britain. The barbers became the guild of barber-surgeons in 1462, a city company with a royal charter. The sur-

geons disassociated themselves from the barbers by an Act of Parliament in 1745 and became the masters and governors of the art and science of surgery. Later in 1800 they were incorporated by a charter as the Royal College of Surgeons of London and in 1843 became the Royal College of Surgeons of England.¹³ Thus surgery had its origin like Cinderella in the scullery and from the ashes and debris was elevated to the companionship of kings, for Astley Cooper (1768-1841) was made a baronet sometime after he had removed a wen from the royal head of King George the IV.¹⁴

The transition of surgery of the sixteenth century to its specialistic elaboration of the eighteenth was roughly 138 years, or the span of years from Paré to John Hunter (1728-1793). There are many points of similarity in the lives and surgical activity of these two men. In the mental equipment of both was a profound intellectual curiosity and ability to observe, to compare, and to record, combined with a positive genius for experimentation. Hunter's famous injunction to Jenner (1749-1823), "Don't think, try: be patient, be accurate,"¹⁵ is duplicated by the experience that Paré narrates on the question as to whether a mass of protruding cerebral tissue was fat and not brain. His interrogator insisted that the protruding mass was fat. "None the less," said Paré, "he kept trying to gainsay me by constant argument. At last I told him experiment should decide between us. If it were fat, it would float on water, and would melt if you put it on a hot shovel."

John Hunter and his brother, William Hunter (1718-1783), probably represent the greatest team in the history of surgery. William Hunter was the first great teacher of anatomy. At the time of the Hunters individual surgeons organized classes in anatomy and surgery and a young man desiring to study surgery apprenticed himself and in many instances lived in the domicile of his preceptor. The teaching of William Hunter differed from that of his contemporaries in his original research

work, in the application of anatomy to surgical procedures and in the fullness and thoroughness of his instruction. His far greater brother, John Hunter, was to advance both the knowledge and practice of surgery to a new level of science. Hunter was the first great comparative anatomist and physiologist. He was the founder of experimental and surgical pathology. He believed that the principle called "life" existed beyond mere structural and functional morphology. His practical mind applied the lessons of comparative anatomy to the elaboration of the physiology of the human. He was the first great pathologist and never lost sight of the practical utility of pathology as a means of surgical knowledge, treatment and prognosis.

He was the first to claim that knowledge of anatomy alone is not a sufficient foundation for the study of surgery. He was to add to the physiologic researches of Harvey and to establish the first great collection of pathologic material now represented by the Hunterian Museum in London. From the encyclopedic range of his mind he might be called the Leonardo da Vinci of surgery. His varied researches included studies of geology, hibernation of animals, coagulation of blood and body fluids and descent of the testis in the fetus. He was the first to discover that the blood of primates and red blooded animals is in the beginning colorless thus resembling the blood of the invertebrates.

John Hunter "found surgery a mechanical art and left it an experimental science."¹⁵ He extended the horizons of medical knowledge, elevated the social status of the surgeon and gave them a position of assured scholarship and educational background. He richly deserved the title of Father of Modern Surgery and justified the words of one of his colleagues, "He alone made us gentlemen."

His research genius is well illustrated by an example. Along about 1785 he tied one of the external carotid arteries of a buck and observed that the antler on that side became cold and growth was retarded.

Some weeks later he found that the antler had regained its heat and was again growing. On doing a post-mortem examination he discovered that the external carotid artery had been well tied and was completely occluded but under the "stimulus of necessity" a collateral circulation had been established around and over the occluded artery. It was from a planned experiment such as this that Hunter devised his operation for popliteal aneurysm, a surgical procedure that has saved numerous lives, no less than limbs, while Hunter's canal has become the anatomic landmark for his operation. Nothing in the realm of human knowledge seems to have escaped his scientific curiosity and whatever problem engaged his interest he left it enriched by his genius. The master word of his life was work.

Surgery is based upon three fundamental conceptions:¹⁶ (1) the control of hemorrhage; (2) anesthesia, (3) the prevention of infection—sepsis. The control of hemorrhage by various technical procedures is as old as man. Certainly, in the most rudimentary society hemorrhage was probably the first and foremost cause of death. The practical mind of primitive man must have devised means of stanching the flow of blood. In the earliest archeologic records are found illustrations and descriptions of various types of tourniquets and the methods of their application. The ligature as a means of stopping hemorrhage in wounds goes beyond the antiquity of Greece.

Anesthesia, a word coined by Oliver Wendell Holmes, cannot now receive the treatment that it deserves. The first allusion to anesthesia occurs in the first chapter of Genesis, when God created Eve, He "caused a deep sleep to fall upon Adam." Literature is rich with its references to various medicaments that might assuage pain—Indian hemp, poppy, henbane and mandragora. Ulysses and his daring companions were narcotized by nepenthe, and Christ is alleged to have received a draught of vinegar and myrrh. The Chinese used

bang and hasheesh, *Cannabis indica*.¹¹ Crude opium and derivatives had extensive use through the middle ages. Marco Polo probably had some opium in his baggage when he returned from China. The caravans carried on an active trade in drugs and transported opium from the far East to the Mediterranean.

The discovery of anesthesia has been told many times. The painting by Robert W. Hinckley of the first planned demonstration of general anesthesia with ether by Morton on October 16, 1846, at the Massachusetts General Hospital is familiar to all. The fate of the men identified with ether anesthesia, with the exception of Long, was tragic in the extreme. He alone seemed to have carried on his ordinary life as a physician and his tragedy was in his delay in having an official publication of his discovery. Wells, in a fit of despondency committed suicide. Morton tried to patent ether under the name of "letheon," but died of apoplexy in abject poverty, while Jackson spent his last days hopelessly mad.

Anesthesia changed the character of surgery. From being a technical procedure of great skill, speed and dexterity, reserved solely for emergency operations and formerly associated only with grave wounds of violence, such as the battlefield—"for the blood of soldiers made many surgeons"—surgery, after anesthesia became an elective operation where speed, dexterity and manual strength were relegated to the background, while precision of mind and surgical judgment became the dominant factors. Surgery was a very precise, technical procedure before anesthesia and Lister, as witnessed by the outstanding names of the seventeenth and eighteenth centuries in England, Wiseman (1622-1676), Cheselden, Astley Cooper (1768-1841), and later Liston (1794-1848) who could amputate a thigh in the miraculous period of three minutes or less by using his left hand as a tourniquet.

Anesthesia enlarged the domain of surgery. It made possible the "planned operation" with its careful preoperative

preparation. In a more subtle way, it advanced surgery because of the change it wrought in pathology. Before anesthesia pathologic material was largely composed of amputated legs, a few tumors and post-mortem examinations. In essence the pathologic examination was a mortuary affair. With anesthesia came "the pathology of the living," the visualization of tissue changes during the life of the individual. Thus a new concept of pathology was to be written as the result of anesthesia and the planned operation. Much, however, remained to be accomplished. Surgery was to be made safe for the patient.

Pasteur (1822-1895) was born twenty-nine years after the death of John Hunter. Although a chemist he is one of the tutelary gods of medicine and occupies an exalted place in the Pantheon of Science. His researches destroyed the theory of spontaneous generation, established the germ theory of disease and initiated the science of bacteriology. It is a notable fact that medicine has benefited repeatedly by discoveries in the realm of pure science. It may be stated that the precise chemical and physical research of Pasteur with isomeric tartrates was the initiatory step that made Listerism possible. Isomerism had been noted before Pasteur. It was also known that there was deposited from wine lees two kinds of tartaric acid: one of these was dextrorotary to polarized light, while the other possessed no rotary power. Pasteur demonstrated that the inactivity of the one acid was due to its being composed of two isomeric constituents, one of which was dextrorotatory and the other levorotatory. When the two isomeric constituents were fused there was no rotation. Following this discovery Pasteur prepared the inactive form of tartaric acid and later observed that when this was fermented by a special mould—*pencillium glaucum*—the right-handed dextrorotatory acid alone was destroyed. In turn he studied the "souring" of beer and wine sickness and proved that the various changes which occurred in the process of fermentation were due to the

presence of invisible organisms and that these germs were not spontaneously generated. Every living thing comes from a similar and preceding form—*omne vivum ex vivo*. Later, he devised the mechanism for developing immunity against cholera, anthrax in animals and hydrophobia in humans. In the field of preventive medicine he shares with Jenner the extraordinary distinction of having devised an effective means of preventing a disease without its causation being known. My mind likes to dwell upon great personalities who throughout time have become crystallized into symbols of scientific progress. Pasteur began his career with the master word for great accomplishment—work. The last words he ever uttered were “Il faut travailler.” It is necessary to work! In 1854 Pasteur was appointed professor of chemistry and Dean of the Faculté des Sciences at Lille. In his inaugural address he stated, “In the field of observation chance only favors those who are prepared.”¹⁷ Joseph Lister (1827–1912) was born one year earlier than Pasteur and “was prepared,” for the philosophy of Pasteur was to introduce Listerism and aseptic surgery. Modern surgery was to be consummated.

It is an ironical fact that while anesthesia enlarged the field of surgery, both technically and diagnostically, it increased the deaths from sepsis. Hospitals were held in great dread as a place where death was inevitable. Five major infectious conditions dominated the mortality lists—hospital gangrene (sometimes spreading through the entire ward or hospital), pyemia, septicemia, wound suppuration and erysipelas. By anesthesia “surgery had enlarged its freedom only to find the weight of its new responsibilities more than it could bear.”¹⁸

Few of us can realize what antiseptic surgery really initiated. Many of Lister's contemporaries were under the impression that it was a new form of chemical treatment of wounds. Its basic philosophy was somehow lost sight of in the controversy

that followed. Taking Lister's own work, we can form some idea of what was accomplished by comparing his statistics on amputation before and after the application of his method.¹

Years	Cases, No.	Recoveries, No.	Deaths, No.	Mortality, Per Cent
1864–1866	35	19	16	43 without antiseptics
1867–1870	40	34	6	15 with antiseptics

The immediate changes induced by antiseptic surgery can also be roughly measured by the death rate for amputations. In the Pennsylvania Hospital for thirty years before 1860 the mortality rate after amputations averaged 24.3 per cent, in the Massachusetts General Hospital, 26 per cent and at Zurich the rate was 46 per cent.

Sir John Erichsen, professor of clinical surgery at the University College Hospital, London, wrote, “A general mortality of many years from 24 to 26 per cent in all major amputations may be considered a very excellent result. It is one of which we need not be ashamed.” To learn in more definite terms, however, what was to happen after Listerism is to understand the magnitude of the extension of the field of surgery. Taking for example, St. Bartholomew's Hospital in 1848, it had 397 beds for surgical patients yet not more than 400 operations were performed each year and approximately 100 of these were amputations. In the year in which Lister died, 1912, St. Bartholomew's had relatively the same number of surgical beds, but 3,561 operations were undertaken and exactly 25 of them were amputations, or 0.7 per cent.¹⁴

Amputation was the most frequent surgical operation by the middle of the nineteenth century. A simple fracture recovered without infection. A compound

fracture always became infected. The patient would either die of general sepsis, without amputation, or suffer an amputation, with a 25 to 50 per cent chance of dying, or make a recovery after an interminable period of wound infection. There is only one circumstance in these two examples that is fundamentally different, namely, the compound fracture had a laceration of the skin and an atrium for the admission for microorganisms.

Robert Brown (1773-1858), an English botanist, had published in 1827 an article dealing with certain rapid movements and oscillations of particles both when observed in a beam of light in a dark room and also under the microscope. Later, John Tyndall (1820-1893) had described floating matter in the air. Pasteur had shown in one of his experiments that the air at the top of a high mountain was practically sterile and free from life or floating particles, while the atmosphere on the surface of the earth, or in rooms, halls or on the streets was literally alive with micro-organisms. Pasteur had destroyed the theory of spontaneous generation and from his studies Lister was able to establish two fundamental concepts: (1) that putrefaction was due to germs and that these germs were either in the air, in the wound, upon the persons or on the materials that touched the patient; (2) these germs did not originate "de novo" but came from other germs exactly like themselves.

The surgical philosophy of antiseptic surgery was gradually developed by Lister from a well considered and reasoned hypothesis. In 1853, in a paper, "The Early Stages of Inflammation," Lister determined that inflammation was essentially the reaction of body tissues to irritation, accompanied by an increased vascularity and dilatation of the blood vessels with a flux of both red and white corpuscles into the area. Unknown to him apparently was the work of Wallin six years earlier in 1847 who had demonstrated that inflammation was essentially diapedesis of the white blood corpuscles from the blood vessels

into the wound. Further weight was given to this early premise by Cohnheim in 1878 who came to the conclusion that the migration of white blood cells into the area of inflammation was the basic feature of inflammation and pus was simply a collection of dead and disintegrating white leucocytes. In the *Lancet*, of March 16, 1868, seventy-two years ago, Lister published the first of his epoch-making contributions entitled, "On a New Method of Treating Compound Fracture, Abscess, etc., with Observations on the Condition of Suppuration." He developed his conception as follows:¹⁹

"Turning now to the question how the atmosphere produces decomposition of organic substances, we find that a flood of light has been thrown upon this most important subject by the philosophic researches of M. Pasteur, who has demonstrated . . . that the air owes this property, but to minute particles suspended in it, which are the germs of various low forms of life . . . Applying these principles to the treatment of compound fracture . . . it appears that all that is requisite is to dress the wound with some material capable of killing these septic germs. . . . In the course of the year 1864 I was much struck with an account of the remarkable effects produced by carbolic acid upon the sewage of the town of Carlisle, the admixture of a very small proportion not only preventing all odour from the lands irrigated with the refuse material, but, as it is stated, destroying the entozoa which usually infest cattle fed upon such pastures.

"My attention having for several years been directed to the subject of suppuration, more especially in its relation to decomposition, I saw that such a powerful antiseptic was peculiarly adapted . . . for the treatment of compound fractures.

"My first attempt of this kind was made in Glasgow Royal Infirmary in March 1865, in a case of compound fracture of the leg. It proved unsuccessful, in consequence, as I now believe, of improper

management: but subsequent trials have more than realised my most sanguine anticipations."

At first Lister believed that the air was the main feature of infections. It was many years before air contamination was to be proved the least important factor in the development of sepsis. The fact that a pathogenic micro-organism must come from other pre-existing forms of the same type explained contact infection and the contagiousness of infection in hospital wards. It was not long, however, before the air acquired a secondary place and antiseptic surgery was to give way to the perfected Listerism—aseptic surgery, about 1890.

Von Bergman was to devise the steam sterilizer in 1886, and in 1890 W. S. Halsted, then of New York, was to have bronze casts made of his hands, and introduced rubber gloves into surgery—"the hand of iron in the glove of rubber." Even as late as 1913 in the Post-Graduate Hospital in New York City, it was necessary to make it mandatory for surgeons to wear rubber gloves during any surgical operation.

Sir John Erichsen, professor of clinical surgery, at the University College Hospital, London, where Lister served as a house surgeon, in the course of an address in 1873, five years after Lister's paper, stated: "The art of surgery is but the application of manipulative methods to the relief and cure of injury and disease. Like every other art, be it manipulative, plastic or imitative, it can only be carried to a certain definite point of excellence. An art may be modified, it may be varied, but it cannot be perfected beyond certain attainable limits. And so it is, and indeed must be, with surgery. There cannot always be fresh fields for conquest by the knife: there must be portions of the human frame that will ever remain sacred from its intrusion, at least in the surgeon's hands. That we have nearly, if not quite, reached these final limits, there can be little question." A year later Erichsen was

to add that, "The abdomen, the chest, and the brain would be forever shut from the intrusion of the wise and humane surgeon."¹⁴

Lister made his first announcement of antiseptis in 1867 and visited the International Medical Congress in Philadelphia in 1876. Five years later, on July 2, 1881, President Garfield was shot through the chest and died two months later on September 19, 1881, of sepsis, fourteen years after the discovery of antiseptis. It is interesting to note that at the time of Lister's visit to Philadelphia, Samuel D. Gross (1856-1882) was professor of institutes and practice of surgery at Jefferson Medical College. In the "Autobiography of Samuel D. Gross, M.D.," edited by his sons, there are two references, and *only* two, to Lister. "Our first stopping place (1868) was the old Royal Infirmary (Glasgow) in the building in which Professor Lister, first put in practice what is now known as his dressing." Again, 1880, twelve years later, "Directly opposite to me was Mr. Lister the famous reformer of the surgical treatment of wounds and other injuries."²⁰

If the Emperor of American Surgery²¹ missed the philosophy of Listerism in 1880 is it any wonder that for many years it was considered a new fangled dressing for wounds. The American adoption of Listerism and its perfected by-product, aseptic surgery, was to await the arrival of William Keen as professor of surgery at Jefferson in 1889. The way of the reformer was more difficult than the way of the transgressor.

It is sometimes interesting to observe how frequently an idea germinates in the minds of different individuals at the same time. This coincidence has frequently been demonstrated in literature in which authors thousands of miles apart and unknown to each other have written approximately the same story. Darwin's origin of the species was almost duplicated by Wallace in India and the descriptions of the radical amputation of the breast by Halsted in Baltimore and Willy Meyer

in New York were published within two or three weeks of each other, and the work of each was totally unknown to the respective authors.

By way of digression we may take up the story of two physicians: one an American doctor, an anatomist and a great master of literature; and the other a young Hungarian physician in far away Vienna. In April, 1843, Oliver Wendell Holmes published an article in the *New England Quarterly Journal of Medicine and Surgery* on "The Contagiousness of Puerperal Fever."²² "The disease known as Puerperal Fever is so far contagious as to be frequently carried from patient to patient by physicians and nurses." The hypothesis of Holmes' occasioned one of the most celebrated controversies in American surgical literature. Dr. Hugh L. Hodge, professor of obstetrics in the University of Pennsylvania, in 1852 responded: "The discussion will . . . divest your minds of the overpowering dread that you can ever become, especially to woman, under the extremely interesting circumstances of gestation and parturition, the minister of evil; that you can ever convey, in any possible manner, a horrible virus, so destructive in its effects, and so mysterious in its operations as that attributed to puerperal fever." Dr. Charles D. Meigs, professor of midwifery and diseases of women and children in Jefferson Medical College in 1852 contributed his thoughts: "I prefer to attribute them to accident, or Providence, of which I can form a conception, rather than to a contagion of which I cannot form any clear idea, at least as to this particular malady." And, two years later, in 1854, he added rather pedantically, "In the propagation of which (puerperal fever) the physicians have no more to do, than with the propagation of cholera from Jessore to San Francisco, and from Mauritius to St. Petersburg." Thus began a surgical epic.

In Vienna, in 1844, Ignatz Phillip Semmelweis, had just graduated from the Medical Department of the University of

Vienna. In the Lying-in Hospital of Vienna there were two departments. In the first the women in labor were attended by medical students, with a maternal mortality never less than 10 per cent and usually over 30 per cent. In the second hospital, the women in labor were attended by midwives with a maternal mortality of about 3 per cent. The horror of the maternal mortality in the first hospital on the extraordinarily sensitive mind of Semmelweis was emphasized by the visits several times a day of the priest, proceeded by a choir boy tinkling a bell to give the last sacrament to the dying. "The bell became an exhortation to search for the cause." Semmelweis attended the post-mortem examinations on the women dead from puerperal sepsis and four years later he was to be present at the autopsy on one of his friends who had died of blood poisoning; the result of injuring his finger when performing a post-mortem examination upon the body of a woman who had died of child-bed fever. Semmelweis was impressed when he saw that the tissues of his dead friend were exactly similar to those observed in the women dying of puerperal fever.

The answer to the causation and transmission of puerperal fever was at hand. The medical students left the dissecting room and delivered the women in labor in the first hospital. Therefore, the "contagium vivum" was carried by the students. A great surgical epic began with the simple injunction "you must wash your hands."¹² Semmelweis wrote: "In order to crush the cadaver fragments adhering to the hands, about the middle of May 1847, I used chlorine liquids, with which I and all my students had to wash their hands." The maternal mortality in the first hospital became comparable with that of the midwives in the second hospital. The conquest of puerperal sepsis by simple surgical cleanliness was initiated. Pasteur, Lister and Koch were still in the future but Holmes in America and Semmelweis in Vienna were both present at the dawn of a new era in surgery.

In justice to the subject a few words should be added regarding personal cleanliness and absence of body filth in the evolution of Surgery. The ancient Greeks practised personal cleanliness and their surgery was clean surgery. The Romans with their genius for organization as exhibited by their aqueducts and baths practised clean surgery, and clean surgery is successful surgery. With medievalism the value of temporal life was held in slight esteem. Everything was spiritual and happiness was looked for in a glorious hereafter. The wars with the movements of troops, the crusades and the pilgrimages made beggary a spiritual calling. The flesh was scourged, mendicancy and dirt were everywhere and clean surgery was impossible. One Roger Frugardi, of Palermo (circa 1170), introduced the seton as a means of creating "laudable pus" in wounds. He believed that the healing of wounds by first intention was beyond surgical skill. About 1266, Theodoric, a chaplain of the Preaching Friars, disclaimed against the theory of laudable pus and said: "For it is not necessary as Roger has written, as many of their disciples teach, and as all modern surgeons profess, that pus should be generated in wounds. No error can be greater than this. Such a practice is indeed to hinder nature, to prolong the disease and to prevent the conglutination and consolidation of the wound." Theodoric was as great an original thinker as Lord Lister but he lived six hundred years too soon, for back in 1266 Theodoric was pointing the way to clean surgery. It is rather interesting that Lawson Tait (1845-1899), the leading gynecologist of England of the nineteenth century, was the most empassioned opponent of Lister. Tait never understood antisepsis but insisted on strict surgical cleanliness. He could not see any relationship between sepsis and bacteria, or disease and soap and water. He flushed

his operative wounds, even the abdominal cavity, with boiled water. He practised aseptic surgery before the word was coined.¹⁴

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A HALF CENTURY OF ABDOMINAL SURGERY

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MOST available histories of surgery, such as that by D'Arcy Power, carry the story of the development of surgery to the Listerian and postanesthetic period. Daring surgeons had penetrated the abdomen, and various surgical procedures had been performed involving almost every one of its contents. Few surgeons, however, had deliberately planned abdominal operations, and fewer had had any conspicuous success. With anesthesia and antisepsis the foundations of modern surgery were laid. Thus the edifice of modern surgical science is erected on the pillars of anatomy and bacteriology and supported by anesthesia and asepsis. As Power stated, "Anatomy, indeed, still forms the basis of operative surgery, but physiology is beginning to occupy an important position in the prevention of those conditions which, if left unrecognized, often require surgical interference. . . . There is still much to be explained, much to be differentiated, and much to be done. The older surgeons operated, thinking only to save life; the younger surgeons operate to discover the cause and to prevent its continuance. They operate to cure."

The importance of Lister's discoveries in the rapid development of abdominal surgery cannot be overemphasized. Anesthesia was discovered almost fifty years prior to the period which we portray. The peritoneum formed a barrier which the boldest surgeon hesitated to traverse. And when one of them did traverse it in a bold pioneering adventure, his accomplishment was hailed by some, but promptly forgotten by most. McDowell's great feat could not stand successful repetition, and it was not attempted in large metropolitan hospitals. The fear of suppuration and peritonitis was

too real. The technic of antisepsis, before it gave way to asepsis, was slow to develop. Lister did not abandon the carbolic spray until 1887, six years after Billroth (who at first opposed antiseptic surgery) had successfully removed a portion of the stomach.

The acute intra-abdominal surgical emergency was a vexing problem during most of the nineteenth century. Appendicitis had not been resolved into a definite entity. It had existed in past centuries as a fatal blight, which lack of postmortem study and diffuse peritonitis completely obscured. Addison and Bright wrote a clear and in many ways modern description of the disease in an unpublished manuscript of 1838. Perforation of the appendix associated with peritonitis, however, while recognized by some did not gain scientific prominence until 1886. Fitz' paper of that year was so complete and thorough that modern discussion and investigation has had as yet little to offer in the way of improvement. The recognition of this disease, the treatment of which probably necessitates the most frequent invasion of the peritoneal cavity by the surgeon, is among the most important contributions of American medicine. The scientific analysis of this disease on a clinical and pathologic basis by Reginald Fitz gave world-wide impetus to the removal of the diseased appendix. In England Sir Frederick Treves, the King's surgeon, boldly urged early appendectomy, a plea that fell on a considerable number of deaf ears among the conservative London physicians. Kronlein, in 1884, had already performed an appendectomy in a case of diffuse appendiceal peritonitis. His patient did not recover. It remained for an American, R. J. Hall, first to remove an inflamed appendix. Thomas G. Morton, of Philadelphia, in 1887, was the first delib-

erately to plan and perform the operation of appendectomy. Shortly thereafter came the work of McBurney, Sands, A. J. Ochsner, J. B. Murphy, J. B. Deaver and Fowler. George Ryerson Fowler published a series of papers in 1894 on appendicitis (later published in book form). Fowler was a Brooklyn physician and Wm. Cruikshank, writing in 1912, referred to Fowler as one "without whose name the history of appendicitis could not be written." To complete the story Fowler himself died in 1906 from acute appendicitis (Royster).

Thus, by the turn of the century appendectomy was a well established procedure, only the addition of the Fowler position being considered an additional worthy contribution. This dramatic evolution of the surgery of appendicitis from obscurity to prominence took place in two decades. It began before Lister had completed his antiseptic technic. Yet it owed its existence to the stimulus which his researches had given. The hopeless purulent tragedy which was appendicitis gave way to a new concept of perforative appendicitis. The ubiquity of appendicitis, and the relative impunity with which the surgeon could invade the peritoneal cavity, made hundreds of abdominal surgeons where none had existed previously.

This period at the turn of the century may well be called the formative period of abdominal surgery. During these few years more "firsts" in abdominal surgery occurred than in all the previous ages of mankind. Surgery of the gastrointestinal tract advanced more rapidly than that of any other single system of the body.

Maes has emphasized, in a review of the "Transactions of the American Surgical Association," the sudden interest displayed in gastric surgery after 1900. From 1884 to 1889 not one paper was presented on this subject at the annual meetings. The president of the society mentioned Billroth's operation as "sub judice and on trial." But by 1900, 231 of the 420 pages of the "Transactions" dealt with gastric surgery.

This sudden development of, and the

world-wide interest in, gastric surgery are indicative that surgeons everywhere were searching for new successful means to treat ever present gastric diseases. The history of gastric surgery includes many of the most famous surgical names, although the entire life span of successful gastric surgery lies almost entirely within our modern period.

The earliest operations on the stomach were those of necessity and were possibly performed in antiquity. Schwaben, in 1635, removed a swallowed knife from a farmer's stomach. Paré wrote a treatise on gastric wounds, speaking with the authority of an experienced army surgeon. The most famous American physiologic subject, Alexis St. Martin ("this old fistulous Alex") might readily have been cured with modern surgical methods. Kocher reported a successful repair of a gunshot wound of the stomach in 1884, and Heusner of Barmen (1891) successfully repaired a perforated peptic ulcer.

Gastrostomy early occupied the attention of numerous surgeons. Sedillot, in 1845, attempted unsuccessfully to perform such an operation. Fenger made an unsuccessful attempt in 1853. Sydney Jones reported a successful attempt in 1875; Verneuil published his case report in 1876 and reviewed all twenty previous attempts which were failures. In 1900 Gross, reporting to the American Surgical Society, stated that gastrostomy was a useful operation. By then a multiplicity of technics had developed so that Marwedel described three distinct types of gastrotomies in 1896: (1) Sphincter in abdominal wall (von Hacker); (2) sphincter in stomach wall (Uhlman); and (3) artificial diverticulum or fistula (Hahn, Witzel, Frank and others). In this country Senn wrote papers on the subject in the same year. He noted that gastrostomy carried a much higher mortality than colostomy.

Meanwhile from European clinics came records of gastric operations of another sort. In 1877 Billroth, after repairing a gastric fistula, said "from this operation to

the resection of a piece of carcinomatous stomach there is only a bold step to be taken." That bold step he himself ventured and four years later he reported the first successful pylorectomy. Rydygier and Grieg Smith credited Merrem with first conceiving and carrying out this operation on dogs. J. M. T. Finney was of the opinion that due credit must go to an early American surgeon, John T. Jones. The inapplicability of these operations to the human body at that time was fully realized; indeed, little that was immediately practical came from these endeavors. In 1874, however, Gussenbauer and Winiwarter repeated these animal experiments successfully. With thoroughness they reviewed the material seen at necropsy in Vienna from 1817 to 1875. They pointed out the frequent occurrence of small, resectable pyloric carcinomas which Rydygier considered of fundamental importance. Péan was aware of these experiments also when he unsuccessfully carried out pylorectomy in 1879, as was Rydygier who made a similar attempt in 1880. Rydygier noted two essentials for success: (1) early stage of the disease and (2) a safe operative technic.

To Billroth and his pupils, Czerny, Gussenbauer, Winiwarter, von Mikulicz, von Eiselsberg, Wölfler, and others, gastrointestinal surgery is greatly indebted. The tremendous impact of Billroth's school on surgery became increasingly apparent as the years went by. Gastric resections became almost commonplace. When Kocher, in 1893, reviewed gastric surgery as of that period and lucidly established a number of important concepts, the ideas were not his but actually those of Billroth and his pupils.

By 1891 Billroth had done forty-one pyloric resections with sixteen deaths; twenty-nine of these resections were for cancer. Kocher emphasized the importance of experience. For Billroth and his pupils the mortality approximated 56 per cent in resections for cancer. For other surgeons the mortality was much higher. Wölfler

had indicated, meanwhile, the variations of mortality due to fixation of the lesion. Similar criteria definitely affected mortality rates today in resections for cancer of the stomach:

	Mortality, Per Cent
Small carcinoma without adhesions...	35
Small carcinoma with few adhesions...	64
Large adherent carcinoma.....	91

Some improvement of these figures quoted by Wölfler has occurred but the various ratios still obtain. Early diagnosis and resection of small lesions give the best results in treatment of cancer of the stomach.

The effect of these surgical inroads on previously unmanageable disease is startling. Resection of the stomach became bolder and bolder. Billroth's first technic (gastroduodenostomy) permitted removal of two-thirds or more of the stomach. The Billroth II operation, following Wölfler's invention of gastroenterostomy, permitted even more extensive resection. The development of a procedure for total resection of the stomach was inevitable. Kaiser, in Czerny's Clinic (1876), had performed total gastrectomy on a dog. This dog lived many years and its digestion was studied by the famous physiologist, Ludwig. At his request the dog was killed in 1882. Schlatter claimed that a small piece of cardia was found remaining. Krönlein maintained that the assertion that total gastrectomy had been performed could be rightfully made only if esophageal and duodenal tissue were at the ends of the specimen removed. Schlatter, in 1897, successfully removed the entire stomach. His patient was a fifty-six year old woman who lived fourteen months. Ribbert established histologic confirmation of the completeness of gastrectomy in accordance with the dictum of Krönlein. Successful total gastrectomy, although it was first attempted in America by Phineas Conner of Cincinnati, in 1884, is still a feat difficult to accomplish.

The impetus of Billroth's school carried it far into intricate abdominal surgery.

Refinements were introduced rapidly. Von Hacker, in 1885, advocated posterior gastroenterostomy. The development of gastroenterostomy was on an obviously mechanical basis. The first gastroenterostomy in America is credited to Ransohoff of Cincinnati (1884). W. J. Mayo, however, early emphasized the importance of the drainage principle of gastroenterostomy and he first aroused the enthusiasm of American surgeons for this operation. His reports before the American Surgical Association, from 1900 to 1905, were masterful expositions of the technic and value of this operative procedure. As Maes has said, "There is nothing speculative about the tributes to the worth of the operation which the Fellow of The American Surgical Association uttered at the meeting in 1905." At that time W. J. Mayo was able to report 307 gastroenterostomies for benign disease with nineteen deaths, a mortality of 6.4 per cent. He had had only one fatality in the last eighty cases. The evolution of the modern technic of gastroenterostomy is well depicted in this report. In the cases outlined, the Murphy button was used 157 times, the posterior suture method 128 times. In May of 1901 Mayo-Robson advocated use of the bone bobbin. In October, 1903, C. H. Mayo did the first short (no loop) gastroenterostomy. Moynihan developed his clamp method about the same time. With all the methods then available, the suture and clamp method was concluded to be best. By 1905 the suture method and posterior short loop gastroenterostomy became routine technics. Thus ended an era of twenty-five years of rapid surgical progress. The mechanical contrivances and ingenious devices of J. B. Murphy and others were relegated to an honored corner on the surgeon's shelf. They had served, nevertheless, the purpose of providing the pioneering surgeon with a fairly safe and rapid method of anastomosis.

This formative period of surgery contained the foundations for many other abdominal operations. Langenbeck, in 1882,

had already done the first cholecystectomy and Ohage (1887) did the first cholecystectomy in America. The surgery of diseases of the biliary tract, pancreas and intestine made almost as great strides as did gastric surgery. Cholecystenterostomy was already being done. Winiwarter, whose contributions to experimental gastric surgery were the foundations for Billroth's work, had anastomosed the gallbladder to the colon. W. J. Mayo had reported a case of cholecystenterostomy, with the application of the Murphy button, in 1893. Fenger's contributions to knowledge of the pathology of the biliary tract including the ball valve or "floating stone," further hastened the development of this field. W. J. Mayo credited J. Thornton, Mayo-Robson, Robert Abbe and Charles McBurney with providing adequate means for exploring the biliary ducts. McBurney it was who first removed an impacted stone from the ampulla by opening the duodenum. Winiwarter's error in anastomosing the gallbladder to the colon, thus losing much of its effect on digestion, was recognized. Cholecystostomy occupied the attention of the earlier abdominal surgeons. Moynihan advocated its use routinely for chronic interstitial pancreatitis. Kehr, however, demanded more frequent employment of cholecystectomy. He introduced the use of a tube to drain the biliary ducts, a method which is in wide use today (T tube). By 1902 W. J. Mayo predicted: "Cholecystectomy will rapidly gain in favor and will undoubtedly supersede cholecystotomy in a large group of cases." The problem of reconstruction of the bile ducts was soon met. On this subject W. J. Mayo contributed extensively.

Mayo-Robson wrote extensively in the "Lancet" on diseases of the pancreas and to him much credit must be given. Acute pancreatitis had been described in 1879 by Balzer, who had pointed out the association of fat necrosis. The existence of pancreatic calculi was also recognized and five operations for this disease were collected by Mayo-Robson in 1904. Con-

cerning cancer of the pancreas he was pessimistic. Cholecystenterostomy he considered extremely dangerous and he indicated the high mortality rates.

Surgery of the intestinal tract was making similar but slower progress. Lembert's recognition (1826) of the importance of serosal to serosal anastomosis was of vital importance. He attributed the idea to Dupuytren who performed an operation employing such a technic. The whole subject languished until Lister's work made it useful. Then Czerny, Kocher, Mikulicz and Senn revived it. Incarcerated hernia was one of the first catastrophes to which this technic brought relief. The appalling mortality demonstrated by Lockwood (1891) is indicative of the conditions which prevailed just before the present era began. He reviewed forty cases of hernial incarceration in which the bowel was gangrenous. The mortality was such that only four patients recovered. These cases were all seen at St. Bartholomew's Hospital. Kendal Franks, two years later, pointed out the advisability of resection and end-to-end anastomosis of the bowel. Paul introduced his glass tube in colostomies about this time and showed the feasibility of the "double barreled" colostomy. Colostomy itself became a safer procedure. The device of Amussat, who had ingeniously avoided the peritoneal cavity by the lumbar route, was gradually abandoned. Allingham, Reeves and Cripps established inguinal colostomy. "Loop" colostomy over a rod or other device was introduced by Maydl and by Kelsey of New York. Dinnick in his history of colostomy credits Davies Colleys with the idea of exteriorization of the colon when it is the seat of a malignant growth, although priority is usually given to Block (Thorek). Colleys also advocated delayed opening of the bowel—the operation—"a deux temps." Others credited by Dinnick are Ward of Leeds, a colleague of Moynihan, and Niele of London.

Billroth, in 1876, was first to resect the cecum; after this small tumors of the bowel

were resected frequently. The contributions of Block, Paul and Mickulicz were significant, and C. H. Mayo and W. J. Mayo wrote extensively on surgery of the bowel. Indeed, the obstructive features of appendicitis ("chronic") were noted in passing by W. J. Mayo in 1901 in an article on the cecum. Kraske, Nothnagel, Gersuny and others had attacked cancer of the rectum, of which more was written since it was easier to diagnose.

All these contributions took place in a formative period, when abdominal surgery was yet in its infancy. The rapidity with which it reached maturity is evidence of the purpose it fulfilled.

DEVELOPMENTAL PERIOD

By 1905 gastric surgery had an accepted place in the medical scheme. Its efficacy in the treatment of ulcer of the stomach and duodenum was still unestablished. Its need in the treatment of cancer was imperative. W. J. Mayo had already expressed deep concern over the then prevailing custom of admitting patients with carcinoma of the stomach to medical wards. These patients he said should be brought to the early attention of the surgeon, since only his ministrations offered a chance of cure.

At this time roentgen rays came to the rescue of clinical medicine (Mayo). The work of Cannon laid the basis for roentgenologic study of the gastrointestinal tract. Yet it was difficult for physicians to free themselves of the prevailing concept of visceroptosis first championed by Glenard. Actual study of gastric lesions lagged. Hemmeter, in 1905, was apparently first to suggest the use of the roentgen rays for the study of ulcer. The contributions of Cole, Carman and others brought additional light to bear on the diagnosis of ulcer.

The value of roentgen rays was not established without opposition. Holzknecht, who made the first diagnosis of carcinoma of the stomach with the use of roentgen rays, had difficulty in getting the medical

profession to accept his views. Pfahler made the first diagnosis in this country in 1911. Too much cannot be said of the value of roentgen rays in the diagnosis of gastrointestinal lesions. Today roentgen rays rank first in importance, for exponents of their use can diagnose gastrointestinal lesions with considerable accuracy. The introduction of roentgen diagnosis and the effect of surgery on the increased knowledge of the pathology of the gastrointestinal tract were promptly reflected in the increasing frequency of clinically accurate diagnoses.

The surgeons of this period were intensely active, developing new technics and new operations constantly. Of course, clinical medicine benefited greatly from this surgical progress. Diagnoses and symptom complexes of gastrointestinal disorders became more accurate and better understood.

The treatment of peptic ulcer by surgical or medical means has a complicated history. The obstructive features of duodenal ulcer were adequately relieved by gastroenterostomy. Loreta, in 1882, had performed the first pyloroplasty when, in the course of repairing a gastric fistula, he forcibly dilated a constricted pylorus with his finger. Then followed the Heineke-Mikulicz and Jaboulay methods and, in 1902, the method of J. M. T. Finney. Pyloroplasty at first seemed to most surgeons a logical procedure. It maintained the normal continuity of the alimentary tract and permitted excision of the ulcer. At the Mayo Clinic the first pyloroplasty was done in 1893. Only recently has it lost its wide acceptance. In recent years reports from the Mayo Clinic on pyloroplasty indicate a definite decrease in frequency of its employment, to the advantage, it may be added, of partial gastrectomy. The problem of therapy for ulcer of the gastrointestinal tract was summed up succinctly by W. J. Mayo in 1905 before the American Medical Association:

"It is wise to be conservative and to compel each new departure to bring its own proof. What results can surgery show in

this field? First, it has demonstrated the clinical frequency of ulcer of the stomach and duodenum, not a *new* thing, because it has been shown for years in the autopsy records; second, it has developed a symptomatology which enables the diagnosis to be made, and has demonstrated the operative curability of ulcer and certain associated disorders. Surgery has brought back to a safe ground a large number of ulcer victims, who, after repeated medical cures, had taken to fakirs, patent-medicine venders, Christian (?) Science (?), or were making the best of their condition and using patent foodless foods and a restricted diet. In doing even this much, surgery has been open to sound criticism, first on the occasional selection of an unfortunate case for operation, and second, on the occasional unsatisfactory results of operative interference both as to mortality and to permanence of cure. It is the surgeon's duty to overcome this prejudice by furnishing better results."

The surgical treatment of gastric and duodenal ulcer has developed along quite different lines. The treatment of duodenal ulcer was indirect. An attempt was made to divert the food and alkali from the duodenum, with or without excision. Removal of the lesion has always been attempted by the surgeon when confronted with a gastric ulcer. The Madlener operation is the only one, except gastroenterostomy, in which only an indirect surgical attempt is made to cure gastric ulcer. The introduction of medical regimens, and the efforts of Sippy and Hurst have revived faith in medical treatment of peptic ulcer. In recent years the treatment of duodenal ulcer by surgical means has grown less frequent. Nevertheless, the conviction that a certain percentage of gastric ulcers become malignant has prevented a similar decrease in the frequency of operations for gastric ulcer.

The surgical advance, however, has been nonetheless dramatic in the treatment of ulcer. The Pólya modification of the Billroth II operation, and its modifications by

Balfour, Hofmeister and Finsterer are established in present day surgery. Haberer, meanwhile, has championed the Billroth I method, at least until recently, for the treatment of ulcer.

The experimental work of Edkins, Ivy, Dragstedt, and Mann and Williamson and many others must be recognized as contributing immensely to the understanding of ulcer.

Progress in other fields of abdominal surgery was almost as rapid. A. G. Sullivan described a method of "restoring the continuity of the bile ducts." W. J. Mayo reported several cases in which anastomosis of the biliary ducts to the intestinal tract had been done. Moynihan credited Riedel with the first attempt to reconstruct the biliary duct in 1888. Sprengel was the first, however, to accomplish this successfully. Thus the period of surgery of the bile ducts is entirely modern. The first cholecystogastrostomy was done by Gersuny. The Murphy button afforded a rapid method of anastomosis and was widely used in cholecystenterostomy. Halsted mentioned, in 1900, that attempts had been made to reconstruct the bile ducts over tubes. To W. J. Mayo, Eliot credited the first hepaticoduodenostomy (1904). W. J. Mayo reported his method in 1905. The work of Sullivan and Wilms, McArthur, Jacobson, Walton, Eliot, Judd, Douglas and Lahey further advanced this field. Eliot has written a number of thorough reviews of this subject. W. J. Mayo credited Walton with the suggestion that a flap be raised from the duodenum or stomach to aid in making a mucosal lined tube of common duct. During the period from 1905 to 1920, a gradual reversal occurred in the frequency of use of cholecystectomy and cholecystostomy. Cholecystectomy had been termed "absurd" by Lawson Tait and, in 1893, W. J. Mayo had remarked that cholecystectomy "is mainly practised by a few continental surgeons and is not a popular operation." By 1905, however, he was predicting that cholecystectomy would rightly increase in frequency. This reversal

in trend gradually augmented. By 1921 Blalock was advocating removal of every diseased gallbladder. The massive study compiled in 1923 by Hotz and Enderlin, who collected 12,144 cases of biliary tract disease, climaxed the period of development in biliary surgery. The next year the development of the Cole-Graham test inaugurated a new era.

The period, 1905 to 1920, witnessed the expansion of splenic surgery. Splenectomy was an ancient procedure, having been performed first by Zacorelli of Palermo in 1549. Dorsey, of Ohio, removed a malarial spleen in 1855 with great benefit to the patient. Splenectomy had been done in 1881 for Banti's disease, in 1896 for Gaucher's disease and in 1906 for hemolytic jaundice. Rydygier had advocated splenopexy for wandering spleen in 1895. W. J. Mayo contributed largely to surgery of the spleen and described a technic for mobilizing the spleen which greatly reduced the bleeding. Bevan, in 1897, had advocated a new type of incision which is still considered most useful. McCoy reported that 160 cases in which splenectomy had been performed for rupture of the spleen had been recorded up to 1908. The relationship between the spleen and diseases of the blood was being investigated in several directions. Splenectomy was even being advocated for pernicious anemia. In 1912, W. J. Mayo advised splenectomy for splenic anemia because he believed that the enlarged spleen was contributing to the reduction in "the number and value of the red blood corpuscles and low hemoglobin." Kaznelson performed splenectomy specifically for thrombocytopenic purpura in 1916. The reduction in platelets associated with this disease had been reported by Denys in 1887. Alfred Hess, of New York (1917), independently of Kaznelson, also advocated this procedure on theoretic grounds.

The improved knowledge of the reticulo-endothelial system and of hemopoiesis has established a sound basis for splenectomy. Recently splenectomy has been utilized for

bleeding esophageal varices, a technic first suggested by W. J. Mayo.

The use of omentopexy in ascites received considerable attention during this time. Vanderveer, in 1912, contributed an excellent review of the status of omentopexy. The original operation by Talma of Utrecht was devised in 1889 and was reported by Lens in 1892 and by Talma himself in 1898. Meanwhile Drummond and Morison, in 1896, reported "a case of ascites due to cirrhosis of the liver, cured by operation." Frazier, of Philadelphia (1900), and Greenough, of Boston (1902), wrote splendid articles on the subject but failed to arouse enthusiasm. However, by 1906 Sinclair was able to collect reports of 273 cases with about 33 per cent cures. The operation was definitely brought into favor by Maurice Richardson, who called its usefulness to the attention of the Southern Surgical Association. W. J. Mayo reported twenty-eight cases in which omentopexy had been performed; he modified the operation by drawing omentum into the rectal sheath. Narath previously had advocated fastening the omentum under the skin. The combination of methods by which the omentum is brought in contact with all the layers of the abdominal wall, to afford better collateral circulation ("step operation"), was described by Pemberton (1931).

The history of surgery of the intestinal tract is almost as intricate as that of gastric surgery. Here, too, great advances were made in the first decade of this period. Oscar Block, of Copenhagen, was apparently first to describe the operation for exteriorization, according to a description in abstract by Thorkild Rosing which appeared in a German journal in 1892. Block employed colostomy above the site of obstruction in the same loop of exteriorized bowel. Paul, who devised a method of draining the bowel by means of tubes, described his exteriorization operation in 1895. He did not employ the delayed technic. Mikulicz, in 1902, employed all methods; as a result, the operation was

named for him. Probably, however, Block and Paul deserve priority credit, and perhaps others as well, as Dinnick has stated.

The progress of surgery of the colon for a time was delayed shortly after these remarkable and widely used procedures were described. The ideas which Glenard had propounded concerning visceroptosis and the neurotic personality were adapted to the treatment of chronic constipation. Famous surgeons wrote extensively on various surgical procedures for chronic constipation. An operation was suggested to repair the ileocecal valve. Enteroanastomosis was performed by others. Removal of the colon was advocated for a variety of disorders. The surgical journals of the period are replete with these articles. Many of these operations are now considered of little value. It would be unwise, however, to state that benefit did not accrue from any of these procedures.

Anastomosis of the bowel has been interestingly surveyed by Kerr. In 1923 he stated that 250 methods of intestinal anastomosis had been reported. The most important contributions were those of Lembert, Murphy and Halsted. Connell, in 1900, reported there were at least 120 methods of intestinal suturing. In 1907, Kerr and Parker found eighty more; they reported an aseptic technic; only one such technic had previously been described. Since then, there had been described twenty-one additional methods of aseptic technic, with the use of clamps, buttons, electrosurgical coagulation and other means.

Rectal cancer is a malignant disease next in frequency to cancer of the stomach. The early history of rectal surgery begins approximately with the development of other forms of abdominal surgery. The following summary is from a recent review by Rankin. Amussat, the first to perform lumbar colostomy was also first to excise the coccyx in the treatment of rectal cancer. Kocher, in 1876, removed part of the sacrum also. Kraske, an assistant of von Volkmann, is established as the greatest

contributor to surgery of the rectum. He advocated (1) radical removal and (2) conservation of the sphincter. In the next twenty-five years Hochenegg, Schelky, DePage, Hartmann, Bardenheuer, Rehn, Rydygier and Billroth made many contributions. The first one-stage combined abdominoperineal operation was performed by Czerny in 1883, and was championed by von Volkmann in 1887. Miles brought the operation into general use; other modifications were reported by Pauchet in France, Lahey in the United States and Grey Turner in England. Two-stage operations were devised by D. F. Jones, Coffey and C. H. Mayo and Rankin. Lahey, in 1930, reported a method of two-stage resection of the rectum or rectosigmoid for carcinoma. Other pioneers in rectal surgery (according to C. H. Mayo) were Kocher, Quénu, Gaudier, Trendelenburg, Abbe and Weir.

In the treatment of intestinal obstruction Treves reduced the mortality one-half by relieving the distended intestine by means of incision, aspiration (Greig Smith) or by the use of Paul's tubes. Broca recommended enterostomy for intestinal obstruction in 1901. The toxemia in intestinal obstruction was attributed by Albeck, in 1901, and Murphy and Brooks, in 1915, to absorption of toxic substances. These ideas command respect today.

Diseases of the peritoneal cavity itself were under investigation from the first. Spencer Wells opened the abdomen for tuberculous peritonitis and found that the exposure brought about significant improvement in the patient's condition. Ochsner reviewed the subject in 1902 before the American Surgical Association and reported that laparotomy and evacuation of the ascitic fluid had a most beneficial effect on tuberculous peritonitis.

Meanwhile a number of miscellaneous diseases and operations were reported. The literature abounds with a variety of incisions for this or that operation. Jackson described his "membranous pericolicitis"; Lane, his "kink." The profound anemia associated with operable carcinoma of the

cecum and ascending colon was noted by W. J. Mayo and was not regarded as a deterrent to surgery. The knowledge of intestinal wounds which J. B. Murphy had gained in the Haymarket riots grew with the war experience of others. J. B. Murphy died in 1914, leaving behind him numerous valuable contributions and many colorful anecdotes. His button stood the early intestinal surgeons in good stead, only to be abandoned when technic of suturing improved. He was representative and exponent of an era in surgery which has since disappeared.

The first two decades of the twentieth century saw perhaps the greatest possible development in abdominal surgery. In this period the surgery of the West developed. "Modern surgery was brought from Germany to America by many men, foremost among them Nicholas Senn, Christian Fenger, and Arpad Gerster. . . . Fenger left a school of surgery and from him Murphy, Billings and many others in the West received their inspiration. He may be said to be the father of modern surgery in the West" (W. J. Mayo). The period in which these men lived and worked can be called definitely the developmental era of modern abdominal surgery.

AN ERA OF EVALUATION

In the last two decades a more subtle change has been apparent in abdominal surgery. Previously the technics of surgery were still to be modified, new surgical entities were to be described, but the great pioneering work had been accomplished. Surgical approaches to all the organs of the abdomen had been reported and many thousands of procedures devised. Of these, relatively few are used today. The most radical changes occurred in the evaluation of the results of surgery and its effect on the patient. The greatest benefits accruing to surgery came not so much from the perfection of technic as from the introduction of new concepts. The physiologic as well as the pathologic entities involved in the

successful management of abdominal surgery led to the greatest advances. The special attention paid to preoperative and postoperative care induced striking reductions in surgical mortality. Progress, however, continued unabated in all the fields of abdominal surgery.

Crile, in 1923, stated that on a visit to England he had seen Moynihan resect half of the stomach for a duodenal ulcer in an effort to reduce the secretion of gastric acids. This procedure he compared to resection of the thyroid to diminish hyperthyroidism. Finsterer, in 1925, reviewed the subject of gastric resection for the treatment of ulcer. Richter, in 1913 or 1914, had advocated gastroduodenal resection and Billroth II anastomosis for duodenal ulcer. Haberer and Clairmont also advocated resection but favored a Billroth I type of anastomosis. Haberer maintained that such an operation was more in accordance with physiologic knowledge than were others. Finsterer, however, advocated using a method of resection with a Pólya type of anastomosis. He devised his own modification of the Hofmeister-Pólya operation. The great objection that Finsterer raised to Haberer's modification of the Billroth I technic was that the suture line had the tendency to be incompetent. Finsterer also stated that the Pólya type of resection permitted higher resection, that it afforded a greater reduction in acidity than the Billroth I-Haberer technic and, therefore, that it was more efficacious in preventing recurrence. These observations recently have been confirmed by one of us (Walters).

The debate as to the proper operation for duodenal ulcer was strenuous. Among the many operations offered, selection of the proper method is still difficult. Devine, for example, devised an exclusion operation which he recommended for ulcers of certain types; that is, for chronic, calloused ulcers, particularly of women. For these ulcers, various operations are uniformly successful but probably simple gastroenterostomy is best. Other technics were devised by Babcock (1926), and Connell (1929), and

recently a method has been described by Wangensteen. The diversity of points of view and the ultimate proof that the ideal in surgery of duodenal ulcer has not yet been attained, can be illustrated by the fact that von Schmieden described a method of resection of the lesser gastric curve rather than gastroenterostomy. Wangensteen, on the contrary, recently has advocated resection of the greater curvature of the stomach, converting it into a tube-like structure.

The number of factors involved in the etiology of peptic ulcer is still undetermined. The contributions of experimental surgeons and physiologists have added much knowledge. In the last fifteen years the trend has been away from surgical management of duodenal ulcer. This tendency can be illustrated by figures from the Mayo Clinic; only 17 per cent of all duodenal ulcers diagnosed at the clinic were treated surgically in 1939. At present the most widely used operations are gastroenterostomy, which still retains a useful place, and partial gastrectomy. In this country, A. A. Berg, Strauss and others advocated the latter operation, which has come to replace in recent years the various plastic procedures on the pylorus.

Of gastric ulcer much remains to be learned. The flexible gastroscope, of which Schindler has been the greatest proponent, has added much to knowledge of this disease. The relation of gastric ulcer to gastric cancer has been definitely established. For this reason gastric ulcer requires careful medical management and frequent observation. In this disease a number of operations are valuable, for instance, partial gastrectomy with Billroth I or Pólya anastomosis, or local excision preferably with gastroenterostomy. A reduction in acidity more frequently follows operations for gastric ulcer than for duodenal ulcer.

Knowledge of gastric cancer is in flux. Recent advances in diagnosis have not materially improved the frequency with which cancer of the stomach is discovered in time to be operable. The recent evalua-

tions of Livingston and Pack should prove a great stimulus to further progress in treating this disease. At the Mayo Clinic, Lewis has reviewed more than 6,000 cases in which operation was performed for gastric cancer. Among the surgical procedures are included nearly 3,000 gastric resections. His conclusions, like those of Pack and Livingston, demonstrate that if the lesion is operable the outlook for the patient with cancer of the stomach is as good as for the patient with cancer of any other internal organ. It is appalling to realize that the patient who presents himself to his physician with cancer of the stomach faces only one chance in twenty to thirty of living five more years. This much may be said: any improvement in the resectability rate of cancer of the stomach is due more to the daring and increased technical capacity of the surgeon than to earlier diagnosis. Cancer of the stomach is a major problem in abdominal surgery and remains a "captain of the men of death," yet to be vanquished.

In surgery of the biliary tract it is now recognized that technical skill and clinical judgment must be combined carefully. Mackey, in a review of cholecystitis, pointed out that biliary surgery prior to the introduction of the Graham-Cole test was practically limited to gallstones and their complications. New avenues of approach were opened with roentgenologic visualization of the gallbladder. Mackey quoted Judd (1927): "The number of operations upon the gallbladder has been greatly increased since the general employment of the Graham-Cole method in making the diagnosis."

The Graham-Cole test raised some new problems. The question of removing the gallbladder in the absence of stones is still being debated. But it is acknowledged that the postoperative results are better if stones were present.

The introduction of tests of hepatic function and the suitable preoperative preparation of patients about to undergo surgical operation on the biliary tract greatly

reduced an apparently irreducible mortality (Mayo, Graham).

New methods of diagnosis, treatment and technic are constantly being introduced. The use of vitamins (thiamin chloride), glucose and other measures has greatly aided in restoring hepatic function that has been reduced by associated biliary tract disease. Pribram renewed interest in mucoclasia and carbonization of the gallbladder wall (more recently performed with the electrosurgical unit by Thorek). For removal of stones overlooked in the common duct, Pribram has described a method in which ether has been used successfully to dissolve the stones if a tube has been placed in the duct. To Lahey, who this year is president-elect of the American Medical Association, belongs credit for calling attention to the method by which a biliary fistula can be implanted into the gastrointestinal tract.

The physiology and anatomy of the biliary tract have been studied by Ivy, Boyden, McGowan, Butsch and Walters, and others. Best and Hicken have described biliary dyssynergia, and cholangiography (Mirizzi, Walters and Thiessen, and Best) now has a recognized place in surgery of the biliary tract.

The greatest advance in reducing the risk of operating in the presence of jaundice has been the introduction of vitamin K (Dam, Almquist and Klose, Smith, Warner and Brinkhous and Butt, Snell and Osterberg). Its recent synthesis by Doisy, Fieser and their associates has given the surgeon a strong weapon. The problem of hemorrhage of jaundiced patients was always troublesome. The early literature abounds in descriptions of various methods (calcium, transfusion, etc.) to control hemorrhage in the presence of jaundice. The work in this field affords a striking example of how carefully integrated research and alert clinical interest combined to save many lives.

The treatment of intestinal obstruction was always difficult. It is so today, but the earlier surgeon had many fewer weapons

with which to combat the disease. It was early recognized that relief of distention is important. Dragstedt and his associates, in 1917, found that the so-called closed intestinal loop was lethal to dogs in a short time. Haden and Orr, in 1923, reported the ability to keep dogs with pyloric obstruction alive by giving infusions of salt solution, and Gamble and Ross showed, in 1925, that death from pyloric obstruction was due to a loss of sodium chloride.

Hausler and Foster (1924) recognized the pathologic and lethal factors which distinguished simple acute intestinal obstruction from strangulated obstruction. J. B. Murphy long ago had pointed out the hyperemia of the obstructed small intestine ("black death") due to venous rather than arterial obstruction ("white death").

Robertson Ward (1925) described an apparatus for continuous gastric and duodenal lavage. Wangensteen clearly established the physiologic basis for intestinal decompression by suction (1933). The enthusiasm with which this work has been accepted is convincing evidence of its value and efficacy in the treatment of intestinal obstruction.

Abbott and Johnston further modified intestinal suction by using the longer tube described by Miller and Abbott. Collier and Maddock have contributed extensively to the studies of fluid and electrolyte balance. More recently Fine and his associates have emphasized the value of high concentrations of oxygen in the treatment of intestinal distention. The mask invented by Boothby, Lovelace and Bulbulian has likewise proved of value in administering regulated high concentrations of oxygen.

Ravdin and Johnston, in a recent review, pointed out that with a single exception (Wangensteen) a definite decrease in morbidity and mortality has not followed the newer knowledge of the physiology of the obstructed intestine. However, the introduction of suction and adequate replacement of fluid has probably been too recent to permit publication of large series of

observations. Apparently, careful selection and individualization of treatment will yield good results in the future.

The maintenance of proper fluid and electrolyte balance is an essential recognized by every surgeon. The ease with which unbalance can occur is especially familiar to abdominal surgeons. The tremendous gain which surgery has made through the advances of biochemistry can hardly be estimated. The many methods of parenteral support afforded the surgeon by the use of blood transfusion, infusions of saline solution and other electrolytes, have aided materially in preoperative and postoperative care. More recently the protein deficiencies have been recognized and infusion of plasma, whole blood, serum and amino-acid solutions have been suggested. The paramount interest in preoperative and postoperative care is well illustrated by this year's meeting of the American Surgical Association. Too much cannot be said in praise of the newer adjuncts to postoperative care. The use of oxygen, and at first serum, but now chemotherapy, in the treatment of pneumonia has made this disease a less dreaded postoperative complication than formerly. The problem of pulmonary embolism, insoluble despite Trendelenburg's heroic procedure, is apparently giving way to the newer knowledge and the use of heparin. The treatment of infection by means of the various new "sulfa" compounds is so new and glowing a chapter in medical and surgical history as to beggar description.

The present situation in regard to appendicitis is not satisfactory. Morse and Rader have reviewed the subject for the last twenty years. More than twenty years ago Murphy decried the apparent increase in mortality from acute appendicitis. According to the bureau of vital statistics there were nine deaths in each 100,000 from appendicitis in 1920 and 14.3 in each 100,000 in 1934. In their collected review of 73,000 cases a gross mortality of 4.89 per cent is cited. These are case series reported

in the literature and they feel that the average mortality rate in the United States is more than 10 per cent.

With all these problems new surgical entities constantly arise. The discovery of insulin was of great value to surgery as it was to all branches of medical practice. Shortly after the discovery and use of insulin, the concept of hyperinsulinism was advanced (Seale Harris, 1924). The first islet carcinoma, with hyperinsulinism, was reported by Wilder and associates. Adenomas of the islands of Langerhans have been removed, with cessation of symptoms, by a number of surgeons (Graham [1929], Howland, Whipple, Holman, Walters, and others). Holman (1929) suggested the term "pancreisles" for the islands of Langerhans because much was to be written of them in the future.

The treatment of cancer of the pancreas, an almost hopeless surgical problem, has received renewed attention through the work of Brunschwig, Whipple and others.

Surgery of the spleen is undergoing constant evaluation. The introduction of liver therapy for pernicious anemia and the better understanding of hematology have put the surgery of the spleen on a firmer basis. Present indications for splenectomy are based on a better classification of hemorrhagic diseases (Wintrobe, Whipple). In these diseases greatest progress has been made. Pemberton has reported good results (83 per cent of cures) from splenectomy for hemolytic jaundice, as well as for thrombocytopenic purpura. In splenic anemia the separation of a number of obscure syn-

dromes and the knowledge of liver function available through various new tests have improved results. An accurate diagnosis is important; lack of this accounts for a number of failures following splenectomy.

The concept of regional ileitis introduced by Crohn and Ginzburg is a relatively recent addition to the field of intestinal surgery. To the manner of anastomosis of the intestinal tract many men have made contributions. Various devices, clamps, tubes and instruments of all descriptions have been invented by men of ingenuity. Operations of one-stage and of multiple-stages for colonic resection come and go in favor. Yet with all the variety of methods and means, definite order is appearing. Careful statistical studies are bringing to surgery of cancer of the colon the same clear insight that is beginning to appear in surgery of cancer of the stomach.

We shall not prophesy with the surgeon of sixty years ago, quoted by Harvey Graham, that abdominal surgery has reached an end in its development. It remains, as always, a fruitful and vast panorama in which new discoveries are constantly unfolding new vistas.

We have quoted extensively from the work of many men, but especially have we drawn on the frequent contributions of the late Dr. W. J. Mayo. His career exemplified the era we have tried to picture. His writings were diversified, thorough and brimful of great common sense. From a perusal of his articles it is possible to relive an era of abdominal surgery in its hey-day of new discovery.



PROGRESS IN OBSTETRICS: 1890-1940

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THAT the past half century has brought achievements of permanent value to obstetrics, measurable already by a beneficent saving in human life and happiness, is common knowledge. A glance at these achievements reveals three salient facts: first, that they have been won by the efforts of a large number of very diverse persons—talented investigators, skilled clinicians and devoted crusaders; second, that these efforts have been furthered by an awakened interest on the part of national governments, our own and others, in maternal welfare as a major social problem; third, that our progress, though great in sum, has been made not by spectacular leaps but little by little along the lines of evolution rather than revolution.

So large a group of workers, scientific, clinical and social, has participated in the advance of obstetrics that it is impractical in a relatively brief sketch to mention any fair proportion of those deserving specific credit. To avoid all risk of unjust discrimination, this review will deal impersonally with underlying principles and significant innovations in practice. Make no mistake, however; among those benefactors who could be named are some destined for a permanent place in medical annals. Impressive testimony to the extent and variety of the work now going on is the output of contemporary publications. The Quarterly Cumulative Index for 1939 listed almost two thousand items under the headings *obstetrics*, *pregnancy*, *labor*, *puerperium*, *puerperal infection*, *obstetrical textbooks*, *nursing* and *hospitals*.

The first evidence of the interest of our own government in the protection of motherhood was the publication in 1913 by the Children's Bureau of a free handbook on prenatal care. Shortly thereafter Con-

gress gave financial support to those states that wished to supervise the health of pregnant women in medically backward districts; and an initial appropriation, relatively small, was from time to time increased until the Federal Government and the states together now employ three thousand doctors and nurses and expend annually as much as four million dollars for maternal and infant welfare.

An outstanding characteristic of the half century has been the intrinsic research carried on with the help of laboratory methods—the logical development of a rich clinical heritage. Consider, for example, the subject of puerperal infection. Its contagiousness was proved to the letter by three or four men a hundred years ago and their conclusions quickly wrought revolutionary changes in the practice of midwifery. Our times, too, have witnessed remarkable discoveries pertaining to bacteria that penetrate the puerperal uterus as well as to means for defeating the invaders. But our headway has been deliberate, one step showing us how to take another, and the work has been shared by many, many patient but imaginative toilers. Progress of the kind that has thus elaborated the chapter on puerperal infection seems to me typical of our gains in both the science and the art of obstetrics in the last two generations. What shall we call this quiet orderly process if not evolution?

This attitude of widespread cooperation and scientific thoroughness is admirably illustrated by the cautious acceptance of new methods of anesthesia.

ANALGESIA AND AMNESIA

It was natural that inhalation anesthesia, an epoch-making discovery of the nineteenth century, should be applied to the

pain of childbirth. Such anesthesia, induced with ether, chloroform or nitrous oxide, completely relieves the mother of pain during the expulsive stage of labor. But the administration of these drugs to obstetrical patients must not be prolonged. Otherwise serious complications, such as anoxemia, degeneration of the liver, kidneys or heart muscle are invited. Momentous objections also hold against protracted anesthesia with ethylene, cyclopropane and vinyl ether. Consequently, search has been directed elsewhere for efficient agents to abolish pain during the stage of cervical dilatation.

Failing the abolition of pain, treatment has striven to blot out the memory of it. In 1902, some success in this effort was attained in Germany with "twilight sleep." A decade later an animated campaign to proclaim its merits among the laity got under way in this country. To its use the medical profession raised objections and various modifications of the method were devised. One modification after another was presented as a panacea. Discussion of these procedures ranked high in the agenda of medical societies which invariably reached a Scotch verdict. All fell short in the hands of unprejudiced observers.

Quick to try anything that promised to lift the curse of Eve, obstetricians did not hesitate to employ drugs admittedly dangerous. As might have been expected, regrettable experiences were encountered and communicated to medical journals but received little if any notice in newspapers and popular magazines. Narcotics are administered to parturients orally, rectally, subcutaneously, or intravenously. The drugs that are used include barbiturates, paraldehyde, opiates, scopolamine, avertin, alcohol, ether—not to name them all. Each has strong advocates and bitter opponents. Apart from minor and occasional complications the most undesirable effects are restlessness of the mother and asphyxia of the infant. Which method is best, which the worst, none will attempt to say unless strongly partisan. But on one point agree-

ment is wellnigh unanimous; that is, that current procedures have merely a temporary significance, for they represent a passing phase of the struggle for ideal obstetrical analgesia—the relief of suffering without hindrance to labor or damage to the child.

EMANCIPATION FROM MIDWIFERY

Fifty years ago the branch of medicine that deals with parturition in human beings was called midwifery. In country districts like that in which my father practised, physicians took pride in conducting a delivery without lifting the bed clothes. Not to expose the mother helped to answer arguments against the presence of a man on such an occasion. In keeping with the attitude of the public in both town and city, medical schools still retained the designation *professor of midwifery* and teachers wrote textbooks on *the practice of midwifery*.

Twenty-five years later epochal changes had come about. Microscopic studies together with chemical research in the physiology of pregnancy put a new face upon the problems of parturition, its antecedents and its consequences. Capable workers, multiplying in number year by year, broadened and emphasized the fundamental principles of midwifery by first-rate contributions to the scientific aspects of reproduction in animals and human beings. How great their opportunity was is illustrated by an interview (1915) with the head of an obstetrical department in a well known university. Asked what he thought were the reasons for the success of his career he snapped: "Research! Research in tissue pathology and in bacteriology. Why, in the time since I became a doctor one had only to look through a microscope to make a discovery." Many questions were at hand and the answers fell like ripe fruit into the lap of investigators when new methods of inquiry shook the tree of knowledge.

The result of all this was inevitable. Academic appreciation of the rightful place of obstetrics in medical science and in the medical curriculum dignified everywhere

the position of physicians who supervised childbirth. The expression, *man-midwife*, became obsolete. Obstetrics had shaken off its shackles.

THE MICROSCOPE

The magnification of tissues cut in thin sections and stained with differentiating dyes removed innumerable obstacles to a correct understanding of human physiology and pathology. The discoveries which came thick and fast paved the way for new fashions in clinical medicine; and obstetrics felt the influence, not only of investigations in its own field but also of those pursued in allied subjects. More definite knowledge of embryonic development, for example, prompted fresh concepts of the placenta, membranes and amniotic fluid. Some of the phenomena with clear clinical import thus brought to light in the borderland between embryology and obstetrics are the following:

(1) The mechanism of implantation after the fertilized ovum has reached the uterus. (2) Phenomena associated with ectopic gestation, especially the distinction between tubal abortion and tubal rupture. (3) The possibility of fertilization before the ovum leaves the ovary. (4) The interrelationship of decidual disease, congenital deformity of the embryo and spontaneous abortion—oldest of eugenic devices. (5) The grafting of a portion of one embryo upon the body of another. (6) The successful transplantation of ovarian tissue. (7) Amniotic adhesions, an etiologic factor in the development of anencephalus and of spina bifida. (8) The role of the chromosomes in the mechanism of heredity. (9) The fixing of responsibility for sex determination upon the spermatozoa. (10) Exposure of the fallacy of "maternal impressions" by intimate study of pathologic embryos.

Placentation, now that the story is told directly, has become less perplexing. No longer are students taught human embryology in terms of the chick—deceptive pedagogic strategy. Material gathered from operating room and clinic depicts what

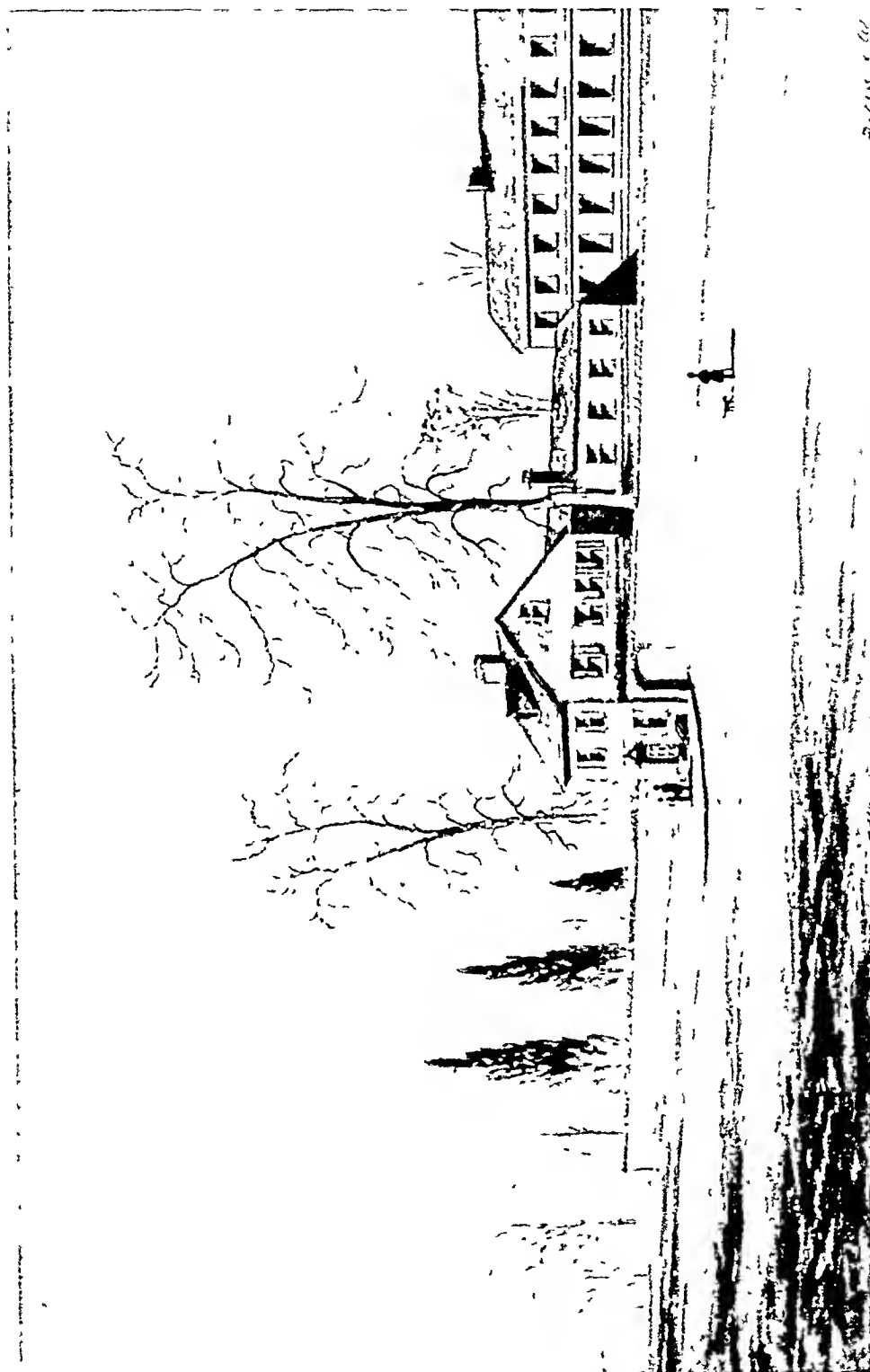
happens to our own species. Of these observations the most extensive relate to the placenta, and beyond the salient features are findings of interest to the specialist alone.

Foremost in importance is the *trophoblast*, the peripheral zone of a recently fertilized ovum which penetrates the uterine mucosa, opens maternal blood vessels and establishes the metabolic interchange between embryo and host. Ordinarily, the trophoblast provides exquisitely arranged epithelial layers to cover the chorionic villi; but occasionally its wild and profuse growth gives rise to an anomaly, *hydatidiform mole* (1895). As the character of the growth is benign in four-fifths of the cases, no excuse exists for hysterectomy routinely. Evacuation of the contents of the uterus suffices. Conservatism has the support of a postoperative follow-up with repeated tests for gonadotropic hormones in the urine, enabling the surgeon to act promptly whenever the laboratory reports a positive reaction.

Chorionepithelioma, likewise a trophoblastic tumor (1895), may either be a sequel to mole or of independent origin. Here again, the hormone urine test has utmost value as a diagnostic and therapeutic guide. Axiomatically the tumor necessitates panhysterectomy. Even so radical a procedure effects cure only if hurriedly undertaken, for the growth metastasizes with shocking speed.

Eclampsia. The pathogenesis of this "disease of theories" was once believed to hinge upon the placenta. In 1893, small trophoblastic emboli, found in the lungs of women who died in eclamptic convulsions, were thought to have etiologic significance. Later it was shown that the emboli were not the cause but the result of convulsions.

Accurate description of the lesions (1902) assigned the characteristic pathologic manifestations of eclampsia to five organs. These manifestations include degenerative changes in the kidneys and heart muscle, edema in the lungs and brain, often hemorrhage in the latter organ, and most intimate



Philadelphia Almshouse (Philadelphia General Hospital)—1732
Sketched by Birch in 1798 and Copied by D. J. Kennedy
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of all, peripheral necrosis of the liver lobule beginning in the periportal spaces. After four decades of experiment the lesions have been reproduced in animals, the technic employed being ligature of both renal arteries (1939). Although attempts to fix the responsibility for eclampsia upon the placenta have thus far proved unsuccessful, an appreciable amount of investigation continues to support the hypothesis that this organ is implicated in the intoxication.

Syphilis. The *treponema pallida* (1905) has been demonstrated in the placenta after meticulous search. Gummata there rank as curiosities, nothing more. However, there are pathognomonic syphilitic changes in the organ, including gross and microscopic lesions. The placenta is larger than normal, very much larger in relation to the weight of the undernourished fetus, alive or dead. Clubbing of the chorionic villi, the specific placental lesion, became insignificant from a practical standpoint in 1907, when the serologic test took its place. In the course of gestation, if the blood test be found positive, arsenical treatment of the mother protects her offspring as well as herself (1910). As yet, the feasibility of rapid cure of syphilis during pregnancy by the continuous intravenous drip administration of organic arsenicals in solution has not been certified. Small repeated doses have been followed in 90 per cent of the cases by the birth of an infant free of syphilitic manifestations. If arsenical treatment is begun before the fifth month of pregnancy and supplemented with intramuscular injections of bismuth, the chances in favor of a healthy infant at birth are perceptibly increased, approaching 95 per cent.

REFORMATION IN ANTENATAL SUPERVISION

The supervision of pregnancy which eminent obstetricians considered adequate three decades ago seems to us strangely meager and casual. In the very best tradition, the doctor assumed responsibility at a consultation early in pregnancy. At that time a short history was taken, a vaginal

examination made and instructions given to submit specimens of urine at definite intervals. A printed list of untoward symptoms was put into the patient's hands with the counsel to report these or anything else that disturbed her peace of mind.

No appointment was made for a subsequent visit to the doctor's office. The next formal consultation occurred when, approximately a month before the expected confinement, the physician called at the patient's home. Then he measured the pelvis, determined the position of the fetus by abdominal palpation, listened to the fetal heart and tried to answer such questions as he was asked. One purpose of the visit was to select in the home a room suited to the conduct of labor. Another was to settle arrangements for the nurse, including the date when her pay should begin, to provide for the equipment likely to be needed and to tell the patient what to do when help should be wanted. The troublesome details discussed at this second and last conference have now been largely eliminated by the willingness of women to enter a hospital for obstetrical attention—the most radical transformation of practice since the turn of the twentieth century.

The old antenatal régime afforded the doctor little chance to learn what was happening to his patient. Aside from urinalysis his only instrument of precision was the telephone. Complications took everyone by surprise and had to be dealt with as emergencies. The opportunity to try prophylactic treatment was wholly lost; and curative measures, when employed, were often too late.

These dangers and penalties contemporary practice seeks to avoid by a type of supervision that calls for constant cooperation between the patient and doctor. For the prospective mother it is education in a proper way of life. For the doctor it is the provision of essential knowledge by means of observations never less than once a month and at shorter intervals near term. From these frequent conferences he can so integrate symptoms and objective findings

as to know whether or not pregnancy is progressing normally.

National concern about prenatal care was manifested long before the end of the last century in France, where there was grave concern about the falling birth rate. Social agencies undertook remedial measures among the less well-to-do. At first their efforts did not go very far. The initial consultation aimed to detect evidence of tuberculosis, severe grades of anemia, cardiac maladies, renal affections, venereal disease, diabetes or any other chronic derangement. Subsequent supervision—dietetic, hygienic, sanitary—was entrusted to a nurse, who reported to the physician when extraordinary symptoms appeared or special treatment was required. From this simple start, prenatal care has spread far and wide since 1901.

Pre-eclampsic Toxemia. At present observations made from time to time in the doctor's office afford protection, of great value even though not absolute, against serious types of toxemia during pregnancy. In the main these tests relate to the weight, the urine and the blood pressure.

The use of weighing scales has a significance out of all proportion to the cost and trouble. They serve as a guide in regulating the diet, which provides the only means we have, though far from perfect, of preventing overgrowth of the fetus. Laying emphasis upon limiting the gain in weight impresses on the patient her responsibility for carrying out with fidelity the other directions the doctor gives. Of the greatest importance is the fact that, since edema of the tissues weighs heavily, the scales can announce the approach of toxemia.

Albuminuria, although recognized as early as 1843 as an alarming complication of pregnancy, has been looked for much more consistently during the past fifty years. Nowadays, specimens of urine are submitted every two weeks. If even a very faint trace of albumin appears, analyses are made more often. When the amount of albumin is measurable, tests are made every day. In the presence of toxemia, the

patient records the amount of urine passed within twenty-four hours, since this is frequently an excellent criterion of renal efficiency.

Estimation of blood pressure (1901) time and again gives the initial clue to the mysterious approach of eclampsia, enabling the physician to prescribe a diet and rest in bed while these simple measures may still be curative. If hygienic regimentation fails, additional treatment will be required, and the prevailing degree of arterial hypertension remains a substantial therapeutic guide.

Though the problems of clinicians present so many variables that strict adherence to arbitrary rules cannot be expected, it is possible to illustrate the prognostic value of elevations in blood pressure by a schedule that obstetricians have found useful. Whenever the systolic blood pressure reaches 140 mm. of Hg., continuous bed rest at home is ordered; at 150 mm. the patient enters the hospital for closer supervision, for intravenous therapy or for other treatment; a blood pressure of 160 mm. prompts discussion of terminating pregnancy. Should hypertension continue to increase, termination becomes urgent in anticipation of convulsions.

Deaths from eclampsia and allied states account for one-fourth of the maternal mortality in the United States, a total of 2,521 women having thus lost their lives in 1938. Terrible as that may be, the death rate was formerly higher. The steady improvement, everyone agrees, has been the result of closer prenatal supervision.

Search for the cause of eclampsia has followed many leads. Much of the research during the past fifty years has been chemical—analysis of the urine, blood, sweat, gases expired from the lungs and even of the placenta and other vital organs. Although such research has revealed facts of utmost importance to pathologic physiology, it has not disclosed the specific cause of this complication. It is no wonder, therefore, that investigators seize avidly upon every new instrument science offers for the

study of disease and apply it to the problems of the toxemias of pregnancy. At the moment the endocrines are on trial. Eminent authorities have suspected (with what promise who can say?) the anterior lobe of the pituitary gland as the provocative agent of eclampsia.

In general the results of prenatal care have improved with each advance in *internal medicine*. Uppermost among recent benefits reflected from that source are the use of insulin in diabetes, vitamins to correct dietary deficiencies, liver and iron to combat anemia and chemotherapeutic agents in the management of pyelitis. With respect to the last complication the place of ureteral catheterization during pregnancy continues to be a subject of debate.

THE LURE OF THE ENDOCRINES

No field of medicine as fascinating as endocrinology has come under cultivation in our time. A remarkable start on the laboratory side prompted clinicians—eager, as they should be, for remedies—to put into immediate practice rudimentary, unoriented knowledge. Of necessity the result of indiscriminate treatment, unchecked and prematurely announced, was confusion; but this confusion did not obscure the brilliant work being done by competent investigators.

To canvass the endocrines thoroughly is beyond my province, for the task assigned to me is a survey of significant contributions to obstetrics. Arbitrarily excluded, therefore, are facts relating to puberty, to the menopause and to gynecologic problems in women of childbearing age. The restriction does not, however, apply to hormone studies that have clarified vital aspects of gestation. Moreover, an appreciation of what has been achieved in obstetrics requires something of background and justifies reference to endocrine research elsewhere. It is pertinent to note that identical sex hormones have been shown to prevail in both men and women and that quantitative sexual variations are characteristic. A distorted concentration of

hormones calls forth masculine traits in women, effeminate traits in men. The anterior pituitary has been accepted as the master gland in the production of sex hormones, but the adrenal cortex also plays a prominent role. Since hormones derived from the anterior pituitary stimulate the gonads, both ovary and testis, a descriptive name, gonadotropic, aptly fits the group.

Gonadotropic hormones elaborated by the chorionic villi and excreted through the urine afford a means of diagnosis of pregnancy in the early weeks. The simply executed test produces a reaction apparent to the unaided eye. By the most convenient method, the urine is injected into an ear vein of a doe rabbit suitable for the experiment. If the woman who submits the urine is pregnant, the rabbit's ovaries will, within forty-eight hours, exhibit a profusion of ripening ova with hemorrhage into the follicles. There is a positive reaction in 98 per cent of normal pregnancies and a negative in the same percentage of women not pregnant.

Repetition of this test corrects the very exceptional false report, unless it pertains to missed abortion or to ectopic gestation. As the production of chorionic gonadotropic hormones ceases whenever hemorrhage breaks the placental attachment, this accident vitiates the urine test in tubal pregnancy. On the other hand, hydatidiform mole and chorionepithelioma produce an unusually large amount of gonadotropic hormones; and in consequence the ovarian reaction becomes exceedingly strong. Measurement of its intensity has, however, thus far proved of no practical value.

Estrogenic hormones are related to and may be derived from cholesterol. Indeed cholesterol is the artificial source of certain potent synthetic preparations of estrogen. Its natural sources include the thecal and possibly the granulosa cells of the ovarian follicles, the amniotic fluid, the adrenal cortex and the testis.

Not until 1896, when successful transplantation of ovarian tissue established the

fact, was there confirmation of the age-old suspicion that the ovaries pour a secretion into the blood stream. Since that accomplishment, how rapid the strides in therapy! At the drug store today under the label *estrogen*, or of some name coined to protect commercial rights, female sex hormone is offered for sale.

After estrogenic substances were demonstrated in the blood (1925) and in the urine (1927), less direct ways were found of following their varying concentration in the body, namely, by biopsy of the endometrium and of the vaginal mucosa and by counting the cells in smears from the vaginal secretion.

Upon the ovaries this hormone has no effect whatever, but it exerts powerful influences upon other sexual organs, primary and secondary, stimulating the growth of the vaginal epithelium, of the uterine musculature and of the mammary glands. Presumably it sensitizes the myometrium to the action of the posterior pituitary oxytocic hormone, laying the groundwork for labor. As term draws near the inactive form of estrogen in the maternal circulation diminishes and the active form increases.

Corpus Luteum Hormone. Not long after operations upon the pelvic organs came to be performed in the presence of an early pregnancy, gynecologists noticed that abortion followed the removal of both ovaries and sometimes of one only. The relationship of cause and effect was defined exquisitely if abortion followed the simple ablation of the corpus luteum. Animal experimentation (1897) and additional clinical observations confirmed the essential character of the contribution of the corpus luteum toward the firm attachment of the early placenta, certainly for two or three months. The responsible hormone, progesterone, has been isolated, its lipid constitution established and even its synthesis effected.

Our clear-cut knowledge of the origin, chemistry and functions of progesterone contrasts sharply with the somewhat hazy information at hand regarding other hor-

mones. Derived mainly, if not exclusively, from the corpus luteum, progesterone inaugurates the preparation of the endometrium for the reception of the fertilized ovum, expedites its implantation, and adapts the maternal tissues to the nutrition of the embryo. Recognition of these facts, as well as of its inhibitory influence upon uterine contractions, inspired the administration of progesterone in cases of threatened or habitual abortion, and promising results have already been reported. Welcome though these are, we remember that enthusiasts recommend vitamin E for the same purpose. Furthermore, the association of abortion with endometritis attributable to the gonococcus has been recognized since the closing years of the last century.

Rhythm. In 1909, the histologic alterations in the endometrium before, during and after menstruation were accurately described; but not until 1915 was attention focused upon learning how nature synchronizes the uterine and ovarian cycles of healthy women. Even so, twenty years more elapsed before the secret was disclosed. Help toward understanding the two timetables came through the measuring of fluctuations in the blood content of estrogen and, by taking calendar dates as criteria, through comparing the curve thus obtained with the rhythmic changes in the uterine mucous membrane each month. A pivotal observation was made in 1928 at the operating table when the surgeon discovered a normal ovum, freshly extruded from the ovary, in transit through the fallopian tube.

This discovery, along with supplementary observations, indicates that ovulation occurs anywhere from twelve to eighteen days before the onset of menstruation. During that period, in the case of women exhibiting the twenty-eight day menstrual cycle, coitus is apt to be fruitful. At other times, as a rule, temporary sterility prevails because of the lack of a ripe ovum. But an absolutely "safe period" can never be predicted, for successive ovulatory cycles vary notably. Upon occasion, unanticipated

deviations in rhythm defeat impartially both attempts to escape conception and efforts to plan a pregnancy that shall begin and end at set seasons.

HEMORRHAGE: ANTEPARTUM AND POSTPARTUM

Hemorrhage now heads the list of puerperal mortality rates. Progress in dealing with this accident has been slower than in the case of toxemia and of infection. To be sure, prenatal supervision affords the opportunity to control hemorrhage promptly when it is encountered during pregnancy. Obstetricians have learned that if absolute rest and generous sedation fail, emptying the uterus is a conservative and not a radical procedure. Among other beneficial agencies, intravenous therapy—saline solution, glucose, and especially blood transfusion—ranks high. Delay in securing a donor is obviated by the blood-banks which are already standard equipment in large hospitals and certain of wider adoption. The maintenance of such facilities is of special importance to obstetrical patients, because they are prone to hemorrhage. Although such patients are partially equipped to withstand the complication, since at term the volume of blood has increased 25 per cent, even moderate bleeding is no longer viewed complacently, and the growing popularity of blood transfusion is one of the hopeful signs of the times.

Premature separation of the placenta from a normal region of implantation has never been fully explained. However, since 1912 we have come to realize that uteroplacental apoplexy is associated with two lesions, namely, detachment of the placenta and hemorrhage between the muscle cells of the uterus. As both lesions impair the function of contraction, the organ becomes distended. Its wall becomes board-like and mapping out of the fetus becomes impossible—developments which point to a correct diagnosis of placental separation. Because muscular disorganization prohibits effective contraction and because the uterus should be evacuated to stop bleeding,

cesarean section may become imperative. At operation a purplish discoloration of the uterus warrants hysterectomy to avoid subsequent hemorrhage, for the damage to the muscle fibers enhances liability to postpartum atony.

Placenta previa is frequently treated nowadays by cesarean section. Procedures recommended in the past—*accouchement forcé*, packing the cervix with gauze, introducing a bag into the uterus, seizing a foot of the fetus and pulling the buttocks down to shut off the placental circulation—have been given up. Elimination of these maneuvers has reduced the death rate from infection and hemorrhage as well.

For adroit means of ascertaining the position of the placenta *in utero* we have x-ray films to thank. They permit measurement of the distance between the fetal head and the mother's bladder in the latter months of pregnancy. If the placenta lies between them, placenta previa, the distance in question becomes somewhat longer. The technic consists of distending the bladder preferably with air. Then stereoplates are made with the patient lying on her back and a supplementary single film is taken in the lateral position. From a study of these views, the location of the placenta may be reckoned, provided its attachment occupies the lower uterine segment. A negative result prompts search elsewhere and persistent effort usually yields the information desired.

For the control of *postpartum hemorrhage*, facilities quite unknown two generations ago are now standard equipment of every obstetrical service worthy to exist. Posterior pituitary extract (1909) and the potent principle of ergot (1932)—variously named by manufacturing chemists—are ready for instant use. On trial, too, is the recently described preparation of oxalic acid for hypodermic administration. Saline and glucose solutions (1920) are nearby, and the blood-bank may be drawn upon without delay.

The possibility of serious bleeding has never passed when the patient leaves the

delivery room, nor even a few days later. Indeed, sudden profuse hemorrhage, late postpartum hemorrhage, may occur at any time in the puerperium. Its most common cause, the retention of placental fragments, calls for the exploration of the uterine cavity and the removal of whatever abnormal tissue is found there. The use of the curette for the purpose has been rightly condemned. Ordinarily a finger or blunt forceps will suffice.

In a few cases of submucous myomata and other occasional complications the control of late postpartum hemorrhage demands hysterectomy. Prompt operation, we have learned, will save life. On the other hand, whenever infection of the uterus is the cause of hemorrhage, hysterectomy is futile. In such a case, measures usually described as medical must be relied on; and efficient treatment has been superbly supplemented by sulfanilamide.

RADIOLOGIC REVELATIONS

As the discovery of roentgen rays was published in 1895, the life history of their application to medicine and the period of this review of progress in obstetrics are practically the same. At first their usefulness during gestation was limited to such direct service as the determining of fetal presentation, skeletal abnormality and multiple pregnancy. As the years passed, especially since 1921, refinements of technic have steadily broadened the scope of radiology until today it occupies an eminent—perhaps one should say pre-eminent—position among the innovations that have advanced the sound practice of obstetrics. We have no more reliable guide to correct prediction when fetal or pelvic dystocia is to be anticipated. For this dependability films showing better detail in two planes are largely responsible.

The mechanism of fetal adaptation to the birth canal, hitherto poorly understood, stands clearly pictured in serial films executed from start to finish of the expulsive stage of labor. Function has thus become a criterion in grouping pelvises, and morpho-

logic concepts have supplemented the etiologic classification. Since we are living in a transition period, a word or two will not be amiss concerning the way in which contemporary obstetricians reach a decision where they anticipate pelvic dystocia.

At routine antepartum examination, the external measurements having been made and the internal configuration of the birth canal explored digitally, the pelvis is nominated normal, flat, generally contracted, rachitic or funnel as the case may be. If some untoward influence upon the course of labor is suspected, radiologic confirmation is sought. The trend of thought then takes a new direction, interpretation of the films proceeding along the lines of the morphologic classification; gynecoid, android, anthropoid, platypelloid.

Flat plates are never trustworthy as an index of disproportion between the fetus and the pelvic canal, because divergence of the rays magnifies objects unequally according to their distance from the film. Correct estimation of essential factors in the mechanism of labor has awaited more perfect development of x-ray technic. Discussion of the ingenious features of this technic would carry us far afield. Suffice it to say that many radiologic procedures have been devised for measuring the fetal head *in utero* as well as the dimensions of the space enclosed within the mother's pelvic bones.

As the multiplicity of methods would suggest, roentgenographic pelvimetry has not yet reached maturity. Some of these methods are complicated, requiring several persons in consultation to master their intricacies, by checking mathematic calculations and other requisites. Simpler procedures may perhaps give dimensions a trifle larger than actually exist, particularly those of the pelvic outlet; but they serve practical if not scientific purposes. Present achievements justify faith in the future. Ultimately, there will be forthcoming a method without limitations, workable alike in well staffed university clinics and in the radiologic departments of small hospitals.

Besides portraying the architecture of the pelvis and elucidating the mechanism of labor, radiology has made many other substantial gifts to obstetrics which, as a token of appreciation, may be summarized in tabular form as follows:

1. Locating the placental attachment to the wall of the uterus.
2. Defining the spread of the pelvic joints during pregnancy.
3. Revealing precisely the presentation and position of the fetus.
4. Giving reliable evidence of multiple pregnancy.
5. Indicating the amount of amniotic fluid; the presence of hydramnios.
6. Depicting skeletal deformities of the fetus and fetus papyraceous.
7. Differentiating pregnancy from pelvic neoplasms.
8. Assisting the diagnosis of hydatidiform mole and missed abortion.
9. Demonstrating collapse of the skull after death of the fetus.
10. Diagnosing fractures in the new born, pulmonary atelectasis, pneumothorax, circulatory abnormalities, gastrointestinal defects and enlargement of the thymus gland.

THE DÉBUT OF THE FUNNEL PELVIS

Prior to 1909, in measurement of the pelvis the dimensions of the inlet monopolized the obstetrician's attention. He assumed that once the fetal head entered the birth canal, certainly when it reached the level of the ischial spines, no extraordinary bony resistance would be encountered unless the patient had a kyphotic spine or some other prominent deformity of the skeleton. This doctrine persisted despite the fact that every now and then there was prolonged delay after the head rested on the pelvic floor, and eventually its expulsion caused a complete tear. For these complications a rigid perineum was held responsible, but we now know the configuration of the bony outlet explains both phenomena.

Whenever the dimensions of the superior strait are normal and those of the inferior

strait are less than normal, the diagnosis is funnel pelvis. Associated with it as a rule will be found an assimilation sacrum containing six vertebrae, the most frequent of pelvic abnormalities. The x-ray, of course, gives clear proof of its existence. It reveals also the frequent presence of a high assimilation sacrum in the anthropoid type of pelvis. From a developmental standpoint, therefore, this anomaly emphasizes kinship between man and the ape.

Routine measurements of the pelvic outlet begin with the transverse diameter, the distance between the ischial tuberosities. But that observation alone is not sufficient. Although the transverse diameter be narrow, normal birth may still be possible, provided the space behind the tubera will accommodate the fetal head. This possibility is appraised by measurement of the posterior sagittal diameter—the distance from the tip of the sacrum to an imaginary line joining the ischial tuberosities.

If proximity of the tuberosities prohibits near approach of the fetal head to the symphysis pubis, the act of expulsion throws great strain upon the perineum. Thus are occasioned the deep lacerations which extend at times through the sphincter ani into the rectum itself. Restricted dimensions of the pelvic outlet may require cesarean section. The size of the fetus, obviously, will be the deciding factor, the decision being reached to best advantage before the onset of labor.

LOW CERVICAL CESAREAN

Now and then a doctor is startled by the calm announcement of a prospective mother consulting him for the first time that she proposes to have "a cesarean birth," as if such treatment were a matter of choice and not compulsion. Sometimes such an attitude is due to unpleasant memories of a previous labor; sometimes a primipara, alarmed by the idle talk of acquaintances, is intent on escape from what she fears will be severe punishment, even with a normal delivery. At all events such incidents speak eloquently of the good

name cesarean now enjoys, in strong contrast with the repute in which it was formerly held. In the history of cesarean births, the modern era dates from 1882 and the practice of suturing the uterine wound at first with silk and later with catgut. Although there were smooth recoveries here and there, doctors continued to hesitate before resorting to the operation and at times hesitated too long.

Alert obstetricians sensed an intimate relationship between the length of labor preceding operation and the character of the convalescence that followed it. Their suspicion was proved correct in 1907 by the analysis of extensive material from the standpoint of "the patient's constitutional equipment when the operation was performed." There was never a clearer verdict. The risk of a cesarean section undertaken at the onset of labor resembled that of an interval appendectomy, whereas death ensued in half the cases when a cesarean operation was postponed until the woman had become exhausted.

Those who took that truth to heart had much less to worry over when the patient left the operating table. Infections became less frequent and the death rate diminished. Yet the need for further improvement was obvious and numerous modifications in technic were suggested. Some of these had short life; others grew in popularity. Foremost among the latter was the low cervical operation, which has reduced post cesarean mortality from 5 per cent to 2 per cent or even less.

Advocated sporadically in 1906 and pictured in a German textbook in 1912, "low cervical" attracted attention in America in 1919. Its merits have been proclaimed with increasing insistence ever since. The peculiarities of the technic, briefly described, consist in severing the vesical reflection of the peritoneum from one round ligament to the other, lifting the bladder from its uterine attachment, and incising the lower segment of the uterus, either vertically or transversely. Which direction the incision should take is a

matter of dispute. The vertical incision requires special care to protect the bladder; the transverse endangers large blood vessels. The latter technic may be the choice of experience; the former must be recommended during a period of apprenticeship.

What is gained by the employment of a low cervical cesarean operation? (1) The uterus is opened in an area well calculated to withstand trauma. (2) At the end of the operation the uterine wound has been covered completely with peritoneum. (3) Vaginal drainage is procured with the least risk of contaminating adjacent structures. (4) A preliminary test of labor—not unduly prolonged—does not prejudice the outcome, though the membranes are ruptured. (5) Convalescence proceeds more smoothly than after the classical operation.

Complete exclusion of the peritoneal cavity from the scene of operation—extraperitoneal cesarean—is commendable only in the presence of frank infection. Many of the extraperitoneal procedures invented have been given up after fair trial, for they jeopardized large blood vessels as well as the bladder and ureters. Whether a technic devised two years ago will, in the hands of random operators, avert the complications fatal to its predecessors, it is yet too soon to say.

Local and Spinal Anesthesia. With respect to cesarean section, objections raised against the use of inhalation anesthesia have been confirmed. Chloroform provokes degenerative lesions in the liver and the heart. Prolonged administration of nitrous oxide or ether has, among other unwelcome effects, that of deeply narcotising the infant. While none of these ill effects are produced by ethylene or cyclopropane, enthusiasm for these gases has been modified by explosions which occurred despite intelligent precautions. The need for new methods has been obvious. Although still on trial, nerve blocking with the less toxic derivatives of cocaine has received stronger and stronger endorsement since 1914. Opinions as to the relative merits of spinal and local anesthesia still

differ; but on one point there is complete agreement. Neither procedure harms the infant. It is fortunate that we have a choice between two good methods.

MINOR OBSTETRICAL OPERATIONS

On the ground that they do much good to large numbers of patients, minor surgical procedures deserve great praise. In the long view, some of them promote health more clearly though less dramatically than major operations.

Episiotomy (1918) in primiparae insures the most perfect perineal restoration possible. A median incision gives the better plastic result; a lateral provides more protection for the sphincter. Good judgment, arrived at with full knowledge of the pelvic outlet architecture, dictates the site of the incision.

Through-and-through silk worm sutures, happily, went into the discard three decades ago. The technic of perineal repair now in vogue, using catgut to reunite vaginal mucosa, muscle and skin in sequence, adds materially to the immediate strength of the pelvic floor and prevents a mechanism responsible for invalidism later on.

Cervical lacerations, formerly disregarded unless they caused postpartum hemorrhage, now receive routine attention in well conducted clinics. The intermediate repair—fourth to ninth day—has grown in favor since 1900, though most obstetricians prefer to suture all kinds of lacerations at the conclusion of labor. The time for doing this operation is less important than its ultimate significance. Everyone shares the conviction that a postpartum cervix should be left as it was when pregnancy began. The attainment of that ideal will reduce among women who have borne children the incidence of gynecologic disease: chronic leucorrhea, erosions, polyps and cervical carcinoma.

ELECTIVE INDUCTION OF LABOR: PRO AND CON

Attempts to bring on labor without the introduction of a bag or bougie into the

uterus have been more successful of late than heretofore. After term is reached trial-induction with castor oil and quinine succeeds in approximately 25 per cent of the cases. When that measure is supplemented by the administration of a very small amount of posterior pituitary extract, the frequency of success approaches 75 per cent. But the efficacy of these procedures reaches 98 per cent after "the waters have broken," provided no mechanical obstruction hinders progress.

Deliberately rupturing the membranes to bring on labor violates a traditional obstetrical canon, and until 1928 it was an unforgivable sin. Our elders condemned such interference because they assumed that the bag of waters dilated the cervix in the normal course of events. But the theory of the hydrostatic wedge has been so completely disproved that it is merely necessary to record its extinction. Actually, dilatation is brought about by contractions of the uterus which rearrange its muscular layers, thinning out the lower segment and pulling the rim of the cervix upward toward the fundus.

During pregnancy the amniotic sac keeps its contents sterile. A broken sac ceases to protect against infection. Nevertheless, the deplorable consequences of premature rupture are confined to cases in which labor was prolonged and vaginal examinations made carelessly or at short intervals. The latter risk is avoided by replacing vaginal with rectal examinations, their value having been recognized since the beginning of the present century.

A protracted labor is due, not to premature rupture of the membranes, but to the presence of pelvic contraction, fetal malposition or some other accredited cause of dystocia. It is incumbent on the doctor to exclude the possibility of such contingencies before he sets out upon induction by any method. Artificial rupture of the membranes, in particular, requires care and foresight and should be practised only by a well qualified obstetrician who has made use of all the prognostic measures at our

disposal, including if necessary x-ray films.

It is clear, in view of the hazards which sometimes halt the progress of labor, that rupture of the membranes can never be employed as a routine procedure. The interval between the time when they are ruptured artificially and the conclusion of labor ought not to exceed twelve hours, a period which ordinarily it is feasible to predict. On that basis only should cases be selected for induction. Proponents of the method find that the interval averages six to eight hours in primiparae, four hours in multiparae. These are the estimates of observers who have adhered strictly to the following dependable rules for guidance: (1) The subjects were approximately at term. (2) The presenting part was well engaged. (3) The cervix had opened sufficiently to admit a finger along with a small instrument suitable for rupturing the membranes. (4) Castor oil, and three to five grains of quinine, or both have previously been administered. (5) Posterior pituitary extract has been applied intranasally, or administered hypodermically in a *one minim dose*, if uterine contractions failed to begin within two hours after the membranes were ruptured.

Favorable conditions for induction prevail more frequently than used to be expected before weekly vaginal examinations during the last month of pregnancy became customary. Such favorable conditions appear earlier in multiparae than in primiparae, but are noted in a majority of both classes. When they are present, elective induction serves the convenience of both patient and obstetrician, for it shortens labor and minimizes damage to the cervix, while it does not increase morbidity, either maternal or fetal.

It should be remembered, however, that calamities following induction have been reported. In some cases, as for example, with cardiac decompensation, the issue would have been fatal no matter what the mode of delivery. In others, the subjects of elective induction were improperly chosen,

without adequate regard for the guiding rules already emphasized. These rules must never be evaded. If after proper care has been taken, complications arise—as they may in any long series of deliveries, whether the onset of labor is spontaneous or induced—the well trained obstetrician meets the situation according to habit, for the contingencies of elective induction differ in no way from those long familiar to the profession.

FIRMER CONTROL OF INFECTION

From first place in our maternal mortality rates, puerperal infection has shifted to third place, thanks to innovations in both prevention and cure. Outstanding are the contributions of the laboratory: precise identification of pathogenic bacteria and synthesis of chemotherapeutic agents. But no less substantial are the strict precautions now taken to avoid contamination of the birth canal. Every day we employ these tactics—details of preparing the patient, proper arrangement of the dressings, disinfection of the hands of nurse and doctor—as if we had practised them always, whereas many of them were the novelties of fifty years ago or had not been devised at all.

Early attempts to disinfect the hands were tedious, cumbersome, sometimes painful, never really satisfactory. The most elaborate toilet required a quarter of an hour: ten minutes of scrubbing with a stiff brush and soap and water, immersion of the hands in saturated solutions first of potassium permanganate, then of oxalic acid, and a final soaking for three minutes in a strong solution of corrosive sublimate. The ritual astonished young graduates assigned by the medical school to obstetrical duty and astonished even more the patients entrusted to their care who had been accustomed to cramped quarters and easy going sanitation. A Negro woman whose five or six children had been born under the ministrations of a midwife of her own race decided on the next occasion to have the hospital doctor for home confinement.

While hygienic preparations were in progress she observed the nurse with puzzled interest. Later, as she watched doctor and student cleansing their hands one after the other, she began to be alarmed. Finally, she blurted out, "Chillun, if I'd know'd you all hands was that dirty, I never would a had you!"

All this changed for the better when rubber gloves were invented. A surgeon devised them because his operating room nurse—whom he later married—suffered continually from a bichloride rash. The original pattern, made of heavy rubber with broad cemented seams, was ill-suited to obstetrical use; but before long it was superseded by a thin seamless design still employed. With hands so covered, the doctor found his sense of touch was not so dulled as to interfere with his recognition of the state of the cervix, the part of the fetus which presented or the location of the cranial sutures, or as to prohibit accurate application of the obstetrical forceps and manual removal of the placenta.

The protection against infection afforded by this simple device is self-evident. It is a contribution no less to obstetrics than to surgery, and merits a high place on the honor roll of notable innovations of our times.

Bacteriology. To the list of organisms that cause childbed fever—a list begun about the middle of the last century with the isolation of streptococcus and staphylococcus from the infected uterus—there have been added the gonococcus (1893), colon bacillus (1893), gas bacillus (1896), typhoid bacillus (1898), and many other bacteria. Extensive studies of the pyogenic cocci have probed deep into their traits of character. At least thirty-six strains of streptococci have been isolated from the puerperal uterus: aerobic, anerobic, hemolytic, nonhemolytic; a complete classification would take us far afield. Yet the theme has important practical implications. The various strains differ in virulence and in resistance to chemotherapeutic agents; and these differences may explain what would

otherwise appear as contradictory clinical results of sulfanilamide therapy.

Sulfanilamide. Through the use of this drug maternal mortality caused by streptococcal infection has been reduced from 23 to 5 per cent—a superlative achievement. Although some of its pharmacologic aspects have not been clarified, it is safe to say that sulfanilamide acts like drugs that destroy intestinal parasites and like organic arsenicals that conquer protozoan invasion of the blood stream. It was the first bacterial chemotherapeutic agent to enter a field rapidly widening in scope.

Although sulfanilamide was synthesized in 1908, its curative effects upon human disease were not announced until 1935. Why the long delay? An enormous amount of experimental work was necessary. On account of its chemical conformation, the properties of the drug are specific. Although it has two thousand near relatives, only a few of them are valuable in therapeutics. Its twin sisters orthanilamide and metanilamide are inert as drugs. To single out the useful member of so large a chemical family took time. Moreover, sulfanilamide has a lethal action only upon certain bacteria, conspicuously upon the beta (hemolytic) streptococci. With all these variables in the problem, time-consuming animal experimentation alone could catalogue the effects of hundreds of chemicals upon two score strains of streptococci.

By a fortunate coincidence, sulfanilamide acts most powerfully upon the type of streptococcus that predominates in childbed fever. Alpha (viridans) and anerobic streptococci, less frequent offenders, resist the drug very much more successfully. The same holds true for staphylococci, pneumococci and gas bacilli. Sulfapyridine qualifies, but not perfectly, as a specific for the pneumococcus; sulfathiazole for staphylococcus, and to sulfanilamide the gonococcus is extremely susceptible.

How do chemotherapeutic drugs retard the growth of bacteria? Scientific curiosity demands more than the coining of terms like *bactericidal* and *bacteriostatic*; it seeks to

learn how the effects are obtained. The action of the drugs remains thus far hypothetical. One theory emphasizes the inhibition of bacterial reproduction, another the impairment of food assimilation. The latter more popular explanation may actually account for the diminished reproduction of the invading organisms and their death.

Adequate dosage of sulfanilamide is regulated by estimating its concentration in the blood of the recipient—a test unique in all therapeutics and most useful. The drug is toxic and its administration is modified or discontinued the moment its concentration in the blood has reached a certain point.

Sulfanilamide therapy is no panacea. As has been said, a great many bacteria are insensitive to the drug. It cures approximately one-half the cases of puerperal infection immediately and spectacularly. In other cases, which respond slowly, it is difficult to decide how much credit should be given the patient's natural powers of recuperation. Somewhat less than one-fourth of the patients who are profoundly infected die in spite of ample medication.

As to the wisdom of using sulfanilamide during pregnancy, opinions differ. It passes through the placenta and reaches the fetus, and harmful results have been observed in experimental animals. Repeated massive doses given pregnant rats stunted intra-uterine growth, caused still-births and increased postnatal mortality. It is obvious that the administration of sulfanilamide to pregnant women with pyelitis or with gonorrhea should proceed cautiously.

Autoinfection. Are bacteria capable of causing puerperal infection to be found in the vagina of healthy pregnant women? This question, argued back and forth for years, has never been quite settled. Uniform methods of investigation, however, have tended to reconcile the conflicting opinions; and the dominant view at present is that streptococci which have been cultured from the vagina during pregnancy are not virulent to the woman who harbors them. In fact, self-infection is looked upon

as highly improbable if not impossible. The agents of childbed fever enter the birth canal from without.

Yet extragenital infections do occur occasionally at the time of childbirth. Recently an epidemic of puerperal peritonitis in a well conducted maternity hospital was traced to primary infection of the respiratory tract. The clues, sifted intelligently, prompted effective prophylaxis. Regulations which banished from the delivery room doctors and nurses whose nasal secretion contained streptococci removed the risk of contagion. The epidemic was promptly wiped out and did not recur.

BETTER CARE OF THE NEWBORN

Although in their efforts to promote the birth of a healthy child, obstetricians succeed much more uniformly than they did half a century ago, the steady decline in infant mortality is to be credited largely to increased efficiency on the part of pediatricians. The mortality rate in the United States in 1939 for infants under one year of age was 48.2 deaths per thousand live births—an all time low. An even more favorable figure, 40 deaths per thousand in New York and Chicago, surpassed the splendid record of the Scandinavian countries prior to 1940 and the European conflict.

These excellent results in America are attributable largely to the systematic supervision now accorded young infants. Though the principles involved cannot be elaborated here, a few outstanding achievements should be mentioned. Surgical treatment of pyloric stenosis has reduced the mortality of this complication from 70 to 2 per cent. Prompt operations on hare-lip and club-foot have become commonplace. Hemorrhagic disease of the newborn has been treated successfully by blood transfusion, and more recently by vitamin K. Pyelitis has been recognized in very young infants and the technic of ureteral catheterization in these difficult subjects has been mastered by urologists. Moreover, the general adoption of many valuable innovations

in infant feeding and in nursery sanitation attests both the skill and ingenuity of the pediatrician as well as his grasp of social problems.

THE VOICE OF STATISTICS

Under the caption, "a medical and social puzzle," an editorial writer in a prominent metropolitan newspaper recently acclaimed the reduction in the rates of maternal mortality and speculated as to its causes. The facts are beyond dispute, for the Census Bureau Report of February 10, 1940, shows that deaths in childbirth decreased 11 per cent in the single year 1938 and declined 30 per cent during a period of ten years. With the thought of socialism as applied to medicine, the editorial writer turned for an explanation to more adequate public health administration with extensive federal and state aid, to subsidized post-graduate instruction, to familiarity of the public with birth control and to a higher standard of living. He was convinced, however, that these influences were not sufficient to account for all the improvement; and for the rest of the solution he left his readers to ponder.

Had the lay writer been able also to look at the problem from within the profession he might have found it less baffling. Anyone who contemplates impartially the handicaps suffered by our elders, who contrasts Victorian midwifery with obstetrical practice stimulated by laboratory and clinical research, will recognize the basic reason for our progress. He will give due credit to more thorough knowledge, applied with increasing competence, and will recognize among obstetricians a steady gain in personal efficiency.

Let us look at the record. In 1938, the last year for which complete data have been published, there were 9,953 deaths attributed to "puerperal causes." This yields a maternal mortality rate of 43.5 per 10,000 live births, the lowest record in the United States. Of these deaths, nearly one-fourth followed ectopic pregnancies and abortions savoring of illegality; and for

these bad obstetrics cannot be blamed. Maternal deaths at or near term were chargeable as follows: to hemorrhage and other accidents of pregnancy, 27 per cent; to toxemias 25 per cent; to infections 24 per cent. Some of these tragedies, presumably, could have been avoided, and the outlook for further diminution of the death rate from such causes grows constantly brighter.

More intimate analysis of the figures for 1938 reveals the fact that, in comparison with the previous year, deaths from infection decreased 12 per cent, from toxemias 11 per cent and from hemorrhage only 7 per cent. Explanation for the favorable trend and hope for its continuance must take into account the quality of supervision now given women during pregnancy and the services available at the time of delivery.

Less obvious to laymen and to semi-professionals than to those who participate in the work are the signs of increasing competence as one generation of obstetricians follows another. Our fathers received diplomas after a two-year course in medicine and opened office at once. The better grounded graduate of today expects his training as interne to fit him to practise independently. Moreover, his apprenticeship in a well managed clinic equips him to profit by the reports in journals, monographs and books and to interpret his personal experience. It qualifies him, in fact, to continue self-education after formal instruction has ended.

The vital statistics gathered by our Census Bureau speak with authority. They tell a story in which we all can take pride, a story of lives saved and health safeguarded, of happiness in homes that would once have been inevitably desolate, of greater human welfare where our need has been most compelling. It is an achievement in which state and federal agencies, research institutions, university clinics and individuals in private practice all have their share. A brilliant chapter in the story, as I have tried to show, is the record of new concepts and new practices, based on the findings of clinic and laboratory. Witness a bead-roll

of praiseworthy contributions to the progress of obstetrics during the period we have passed in review:

1. The hormonal urine test, most accurate of all biologic tests, which affords a very early diagnosis of pregnancy.

2. The role of progesterone in promoting secure implantation of the ovum; of estrogen in sensitizing the uterine muscle preliminary to labor; of the posterior pituitary hormone, in serving as a powerful oxytocic.

3. The recognition of the chromosomes in the nucleus of the sex cells as the physical basis of heredity; and of those of the spermatozoan as determining whether the embryo shall be male or female.

4. The cause and effect relationship between unfitness of the embryo and spontaneous abortion.

5. Identification of fetal tissue as the source of both hydatidiform mole and chorionepithelioma.

6. Recourse to periodic consultations with prospective mothers to consider the significance of ailments, to watch the gain in weight, to regulate the diet and in general to emphasize a healthful way of living.

7. Systematic blood pressure estimates to detect pre-eclamptic toxemia and allied states in their incipency.

8. Serodiagnosis of syphilis; specific treatment with organic arsenicals during pregnancy to protect mother and offspring alike.

9. Definition of uteroplacental apoplexy as the most insidious type of premature placental separation.

10. Application of radiology to the diagnosis of placenta previa.

11. Contributions to the treatment of postpartum hemorrhage: the active principle of ergot, intravenous glucose, blood transfusion, the blood-bank.

12. Radiologic demonstration of multiple pregnancy, of fetal position, of size and deformity.

13. X-ray pelvimetry, featuring functional capacity as a criterion of pelvic classification.

14. Demonstration of outlet contraction as a cause of dystocia.

15. Persistent search for perfect analgesia during the first stage of labor.

16. Local and spinal anesthesia for the performance of pelvic surgery.

17. Refinements in the technic of cesarean section; the low cervical operation.

18. Induction of labor in selected cases by rupture of the membranes.

19. Better execution of perineal and cervical repairs.

20. Isolation of many varieties of bacteria that cause puerperal infection; classification of streptococci.

21. Proof of extra genital infection at the time of labor.

22. The wearing of rubber gloves to prevent contamination of the birth canal.

23. The use of chemotherapeutic agents to combat puerperal infection.



NOTES ON FIFTY YEARS OF PROGRESS IN GYNECOLOGY

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HISTORY has been written in a variety of ways, as a chronologic list of discoveries or events which mark the milestones, in terms of the personalities whose lives typify their day, or as an analysis of trends of thought or organization which characterize a particular epoch. All of these aspects need to be considered even in the fraction of history represented by the record of half a century of progress in a single division of medicine.

In 1891, gynecology was already a well defined specialty, perhaps even more distinct and circumscribed than it is at present. It had been founded upon a series of brilliant technical achievements in the surgery of the pelvis. These accomplishments in turn had been made possible by the recent discoveries in anesthesia, bacteriology and microscopic pathology.

It is interesting to consider for a moment this scientific background against which the gynecology of 1890 was placed. Anesthesia had been in use for nearly fifty years since the 1840's when Long and Morton had experimented with ether, Wells with nitrous oxide and Simpson, in England, with chloroform. "Cellular-Pathologie" had appeared in 1858, but in the early nineties Virchow was still active in science and a member of the Reichstag in Berlin. Pasteur and Koch were alive, although their greatest work had been done some years before. Lister's development of antiseptics, first reported in 1867, was little over twenty years old when this period started.

Gynecologic surgery had in fact made a small but heroic beginning before these discoveries which now seem to us the prerequisites to all surgery. McDowell's "ovariotomy" in 1809 has been justly regarded as the starting point of pelvic abdominal surgery. Sims' work on the

repair of vesicovaginal fistula, published in 1852, had opened the field of vaginal plastic operations and was already a classic by the beginning of the final decade of the century. Most of the operations now employed had their prototypes in 1891, many crudely done, some with an exorbitant mortality. Nevertheless they were all known in principle: plastic operations on the perineum, anterior vaginal wall and cervix, hysterectomy and myomectomy, salpingectomy for pus tube and ectopic pregnancy. The future of pelvic surgery was not to lie chiefly in the discovery of new operations, but in the refinement of already understood technics; and the extraordinary expansion of gynecology as a whole was to take place on the basis of new and undreamed of discoveries in the fields of physics and physiology.

In 1891, the first generation of post-Listerian gynecologists was still at work. Spencer Wells, one of the earliest of the "ovariotomists," was an old man but had several years yet to live. Lawson Tait in Edinburgh was at the height of his powers, but unlike Wells was to come to an early death. In Germany, Hegar, Olshausen, August Martin and other pioneers were still active.

In America a long list of men with remembered names occupied positions whose very titles indicate that the form of organization of university departments in the diseases of women was far from settled. Goodell was professor of gynecology at the University of Pennsylvania and Barton Cooke Hirst already professor of obstetrics. Howard Kelly at this time held the chair of both gynecology and obstetrics at Johns Hopkins. Thomas Emmet was surgeon to the Woman's Hospital and T. Gaillard Thomas, professor emeritus of the diseases

of women and children at the College of Physicians and Surgeons. Skene was professor of the medical and surgical diseases of women at the Long Island College Hospital. William Lusk, exhibiting apparently the ultimate in versatility, was professor of obstetrics, of diseases of women and children and of clinical midwifery at Bellevue Hospital Medical College and was in addition physician to Bellevue Hospital.

At this time New York and Philadelphia dominated the gynecologic scene in America. Johns Hopkins was approaching its great days and Boston appears to have been contributing little that was new to pelvic surgery. Many now great university services had not yet been conceived. Full time hospital and medical school staffs seemed as far off as other aspects of socialized medicine.

When one peruses the scientific papers of this time, one is impressed with the fact that the nineties were a period of hesitation. The anatomic problems of surgical technic has been grasped but the new directions for advance were not clear. In September of 1891, the American Gynecologic Society met in Washington and listened to a variety of undistinguished papers on technical procedures, such as high amputation for cancer of the cervix, on galvanism in the treatment of fibroids, and on the avoidance of operation for ectopic pregnancy by the injection of morphine into the fetal sac. The articles submitted to the "American Journal of Obstetrics and Diseases of Women and Children" in that year indicate that the profession at that time was preoccupied with three subjects, uterine fibroids, pyosalpinx and ectopic pregnancy. A few papers on the physiology of menstruation are now unbelievably archaic in conception. The dearth of articles on gynecologic cancer indicates an attitude of hopelessness toward this disease. A book review on the advice a mother should give her daughter suggests that the gynecologist of the nineties was already puzzled over this problem

and that the situation then was little more satisfactory than it is at present.

The German literature of the time foreshadows the leadership that the universities of that country were soon to exercise in bringing the laboratory closer to the clinic. The articles in the *Archiv für Gynäkologie* for 1891 are longer and better written than most of those in contemporary American journals and show the ponderous thoroughness which was to be the source of admiration and annoyance to the foreign reader. One finds Doederlein and Bumm at work on bacteriologic problems, Pfannenstiel studying the origin of the ciliated epithelial cysts of the ovary. One finds also the beginning of statistical attempts to evaluate the success of treatment of uterine cancer. Of physiology in a modern sense, of a rational therapy of functional disorders there is of course nothing.

The early 1890's were thus characterised by a breathing spell before new adventures. Men had the opportunity to look around and to measure the ground that had been won. The successes of the first quarter century of modern surgery were dazzling and the result was a veritable burst of new textbooks. Within the course of a few years there appeared works on gynecology by Goodell (1887), the Byfords of Chicago (1888), Lawson Tait (1889), Hart and Barbour of Edinburgh (1890), a translation of a series of lectures by August Martin of Berlin (1890), a large treatise by T. Gaillard Thomas and Paul Mundé of New York, and an American translation of Pozzi's fine two-volume work in 1892. Collaborative works were also making their first appearance, as for example, "A System of Gynecology by American Authors" (1887), "An American Text Book of Gynecology" (1894) and finally the first edition of the greatest of gynecologic works, Veit's "Handbuch der Gynäkologie" in 1897.

It is easy to feel a sense of superiority in turning the pages of these works of the earlier days of gynecology. Even their appearance seems old fashioned with their quaint illustrations and fantastic reproduc-

tions of histologic structure. Yet the style is individualistic, and hence often more readable than many of the more formalized texts of the present day. Certain types of cases were still rare enough to justify their recounting in terms of personal anecdote, and new clinical entities must have seemed to lurk about every corner. Opinions were freely expressed, unblushingly, without benefit of statistics or laboratory experiment.

Yet about many common gynecologic diseases there was evidently considerable haziness. Ectopic pregnancy may have been well understood by Tait, but other writers still believed that pelvic hematocele was due to a variety of somewhat mysterious causes. The Byfords devote a section to this disease which they call misplaced menstruation or "metatithimania." Hart and Barbour were of the opinion that pelvic hematocele could follow violent exercise or coitus during menstruation and that the patient was predisposed to the disorder by various conditions of the subperitoneal veins, purpura, scurvy and hemophilia. Salpingitis undoubtedly often passed under the name of perimetritis and there was considerable doubt, an uncertainty which perhaps still exists, in regard to the relative frequency of the gonococcus as the cause of that disease.

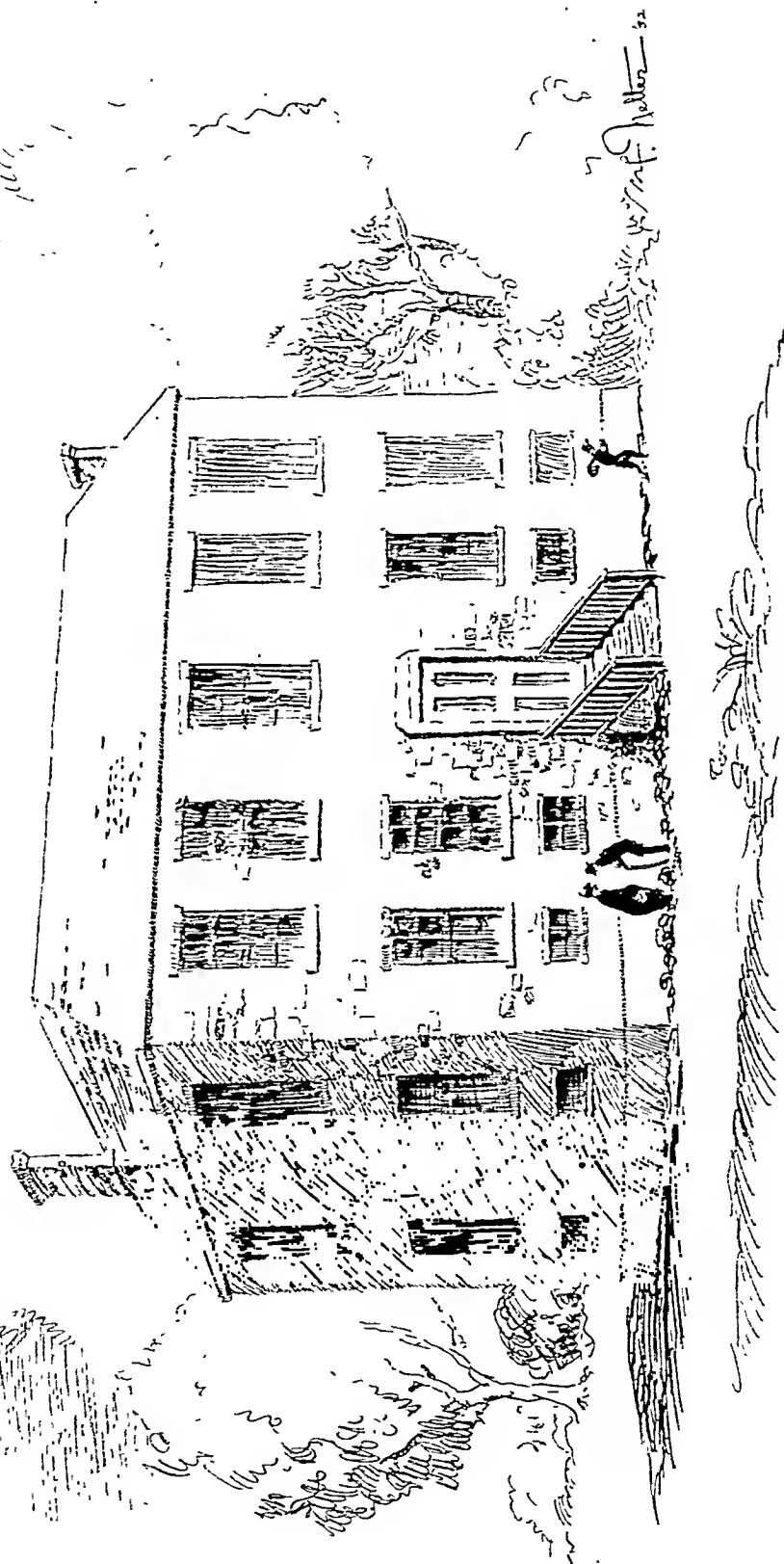
Endometritis was a term applied to a variety of complaints affecting the uterus. Hart and Barbour refer to several supposed varieties, fungous, papillary, senile and exfoliative. Undoubtedly the group included the modern cystic hyperplasias and perhaps several unexplained types of endometrial disorder. The concept of inflammation was a traditional one, tried and dependable; that of a chemically induced hyperplasia was still an hypothesis and unavailable for daily use.

Some clinical conditions, scarcely recognizable by the present day reader, are described so universally by the writers of the day that one wonders whether the moderns may not, in their utter dependence on objectively measurable disorders, be

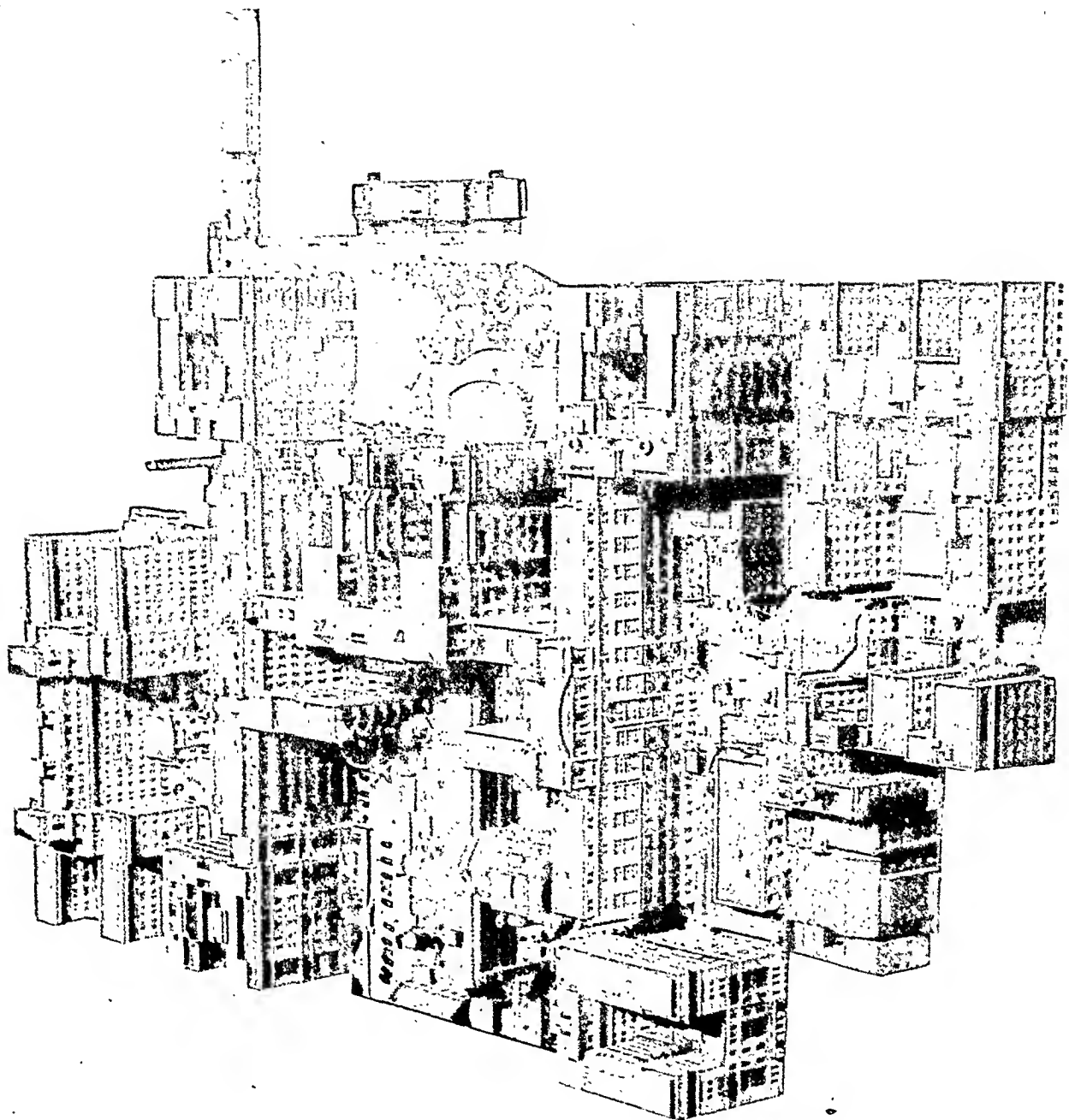
overlooking some of the subtleties of the older practice. The condition that strikes the reader most forcibly is one somewhat vaguely entitled, "chronic metritis" or "chronic parametritis" and "areolar hyperplasia of the uterus." The pathology of the disease was never directly stated, although the more careful writers doubted its inflammatory character. There is no uncertainty, however, about the clinical description. These patients suffered from a cervical catarrh, from backache, bearing down pains, bladder irritability and a variety of reflex symptoms, including, according to Goodell, cold hands and feet, headache, neurasthenia, hysteria and a *facies uterina*. Furthermore the disease was due to improper care in the puerperium, to immoderate sexual activity or to exposure to cold during menstruation.

In other respects, too, the gynecologist of the nineties took a view of his patient which went above the pelvis. Skene devoted four chapters to nervous conditions in relation to gynecology, a point with which most of the men of the time were concerned. True, many ovaries were doubtless sacrificed in the procedure often called Battey's operation for the cure of various complaints such as "hystero-epilepsy, convulsions and threatened insanity," but this point of view kept the specialty from becoming too mechanical and balanced the intense interest in the multitudinous surgical instruments that were being devised. Thomas and Mundé strike a modern note when in a somewhat reckless chapter on "The Etiology of the Diseases Peculiar to Women" they include the prevention of conception and induction of abortion. Beside the effect on the individual's welfare, they believed that birth control was already reducing the number of children in many successful families and that some day this might be a serious threat to the American nation.

With even this glimpse of the gynecologic horizons as they existed before the turn of the century, the extent of the changes that have occurred is inescapable. The pathologic methods of Virchow and



The First Bellevue Hospital —1736



Group of Buildings Comprising Bellevue Hospital Today

his successors have been further applied to the study of all gynecologic lesions until today it seems that no morphologic entities can remain undiscovered. Physiology with biologic chemistry has lately replaced simple morphology as the technic for most advanced research. Radium and radiation have been discovered and applied to the cure of a variety of gynecologic complaints. Above all perhaps the society, in which the gynecologist is working, has changed so that the surgeon has become less an individual performer and much more a member of an organization, whether it be a university, a hospital or a specialty with relatively standardized requirements. A few of the more fundamental lines of progress can alone be briefly traced.

GYNECOLOGIC PATHOLOGY

Although pathology itself was far advanced, the gynecologist of the early nineties was too busy perfecting technic and reducing surgical mortality to indulge himself often in microscopic studies. The change which was to make pathology a part of every medical school course in gynecology and a prerequisite for examinations for certification of qualified specialists was to come gradually. In Germany the interest in this subject was already established in the nineties, and the advances in the field were soon to be almost entirely in the hands of clinical gynecologists. Among the first in America to follow this trend were Henry C. Coe, working at the Woman's Hospital in New York, and Thomas S. Cullen, who made notable contributions on adenomyoma and cancer of the uterus.

The pathologist of the early nineties possessed a good general conception of the commoner uterine tumors and of most of the pelvic inflammatory lesions. Experience had not yet accumulated to allow real accuracy in microscopic diagnosis, and mistakes in the separation of benign from malignant growths were frequently made. Confusion in the classification of ovarian tumors, especially in the solid varieties,

was general. Finally, one of the prerequisites of present day gynecologic pathology, the knowledge of the normal cyclical changes in the ovary and endometrium, was totally lacking. Microscopic sections, showing swollen premenstrual glands, were often diagnosed as glandular endometritis and regarded as a pathologic lesion.

Pfannenstiel's classification of ovarian tumors published in 1898 remained the most generally accepted until little over twenty years ago. The defects in this classification, involving principally the solid tumors, were largely eliminated by the studies of Robert Meyer, beginning in 1915, with a description of the granulosa cell tumors and continuing with later work on the arrhenoblastoma and dysgerminoma. A development of perhaps even greater importance was the demonstration of the frequency of endometriosis which received special impetus from the paper of Sampson in 1921 and was continued with work by Meyer, Lauche and many American gynecologists.

Beside somewhat better recognition of general tumor types, much effort in the early twentieth century was directed toward the study of degrees of malignancy. The inception of this work may be traced to nongynecologic sources and the work of David Hansemann, but the cancers of the cervix supplied particularly valuable material for such investigations. Here the earliest report was probably that of Schottländer and Kermauner of Vienna, who graded cervical cancer into mature, moderately mature and immature forms. The possibility of demonstrating a relationship between prognosis and the histologic grade of malignancy was perhaps lost when surgery gave place to radiation in the treatment of cervical cancer, for in radiated cases the greater radiosensitivity of certain tumors was found to offset their greater inherent malignancy.

The greatest morphologic progress in gynecology has, however, taken place in the field of normal microscopic anatomy which in turn has contributed greatly to

modern physiologic conceptions. Intimations that cyclical changes might occur in the endometrium date back at least to a report of Kundrat and Engelmann published in 1873. Their work remained largely unknown, however, and though some cyclical changes in the uterus were vaguely believed to occur, it was only after the epochal work of Hitschmann and Adler, published in 1908, that the details of the normal changes in the uterine mucosa became a part of the background of all gynecologists. Little in principle has been added to the work of these two men on the normal endometrium, but the recognition of an abnormal pattern, that of endometrial hyperplasia, has added a major entity to gynecologic diseases. For the discovery of this functional disorder and at least its partial explanation medicine is chiefly indebted to Robert Schroeder, but also to Robert Meyer and later to Novak, Wilfred Shaw and to a host of others.

FEMALE REPRODUCTIVE PHYSIOLOGY

Female reproductive physiology was in any modern sense unknown in the nineties. Although it had of course been clear for centuries that the gonads were essential for the developmental changes of puberty, humoral conceptions of physiology were still in disrepute. The year 1888, when Brown-Séquard reported the rejuvenating effects of press juice of testicular tissue, may perhaps be counted as the beginning in the great revolution which has occurred in sex physiology. His extracts were soon followed by others, including an ovarian substance for menopausal symptoms reported by Landau in 1896. That these extracts did not have the properties claimed for them does not detract from their historic importance in giving subsequent investigators a start in the right direction.

After the appearance of the first gland preparations there was little progress for twenty years or more, chiefly because truly satisfactory methods for extraction, concentration and measurement of the hormones were not known. The great advance began again about 1912, the year in which

Adler showed that the uterus could be used to demonstrate ovarian activity and Iscovesco found that the active substances in the ovary, corpus luteum and placenta, were soluble in lipoid solvents. These were the essentials needed for the isolation and measurement of the estrogenic hormones, although a different test object, the cells of the vaginal canal of small rodents, was later to displace the uterus as a result of the anatomic investigations of Stockard and Papanicolaou (1917), Long and Evans (1922) and Allen (1922).

The discovery of another group of substances of prime importance to the gynecologists occurred rather suddenly in 1926 when Smith and Engle and, quite independently, Aschheim and Zondek reported their observations on the gonadotropic hormones. The work of the latter yielded almost at once a practical test for the diagnosis of early pregnancy. Studies on the gonadotropic substances, their chemistry, physiology and probable multiplicity continue as a field of enormous scientific interest.

That there was a second hormone of the ovary with a different function was fairly evident from early experiments of Fraenkel, published in 1903 and 1910, showing that the removal of the corpus luteum in early pregnancy resulted in abortion. Other early experiments with corpus luteum extracts suggested that they produced secretory changes in the endometrium but it was not until the work of Corner and Allen in 1929 that the duality of the ovarian hormone was finally established.

The clinical gynecologist now looks on with amazement at the rapid changes which are being created in his special field by intruding outsiders, physiologists, chemists and other laboratory scientists. New hormones constantly appear. Testosterone is common to both male and female and the adrenal produces sex hormone-like substances. The estrogens themselves have given birth to subtypes and have been concentrated, crystallized and measured. Their physiologic functions multiply almost daily

and a long list of disturbances have been laid at least theoretically at their door.

From these discoveries has arisen gynecologic endocrinology, a science with no past, a dubious present and a boundless future. No great innovators can be named here, for the particular steps which may prove important are not yet evident. To date, the greatest service has been rendered by the men who have held back the uncritical. Only in the treatment of the vascular symptoms of the menopause have the new hormones an established position that one may believe will still be held ten years from now. Nevertheless the future is actually limitless and a little terrifying.

PELVIC INFLAMMATION

For inflammatory diseases of the female pelvis the history of the last fifty years has witnessed first a period of youthful surgical exuberance, a few years of sober reckoning and then a persistent growing and determined conservatism. Noeggerath, in 1872, had dramatized the frequency of female gonorrhea, Neisser had discovered the organism in 1879 and soon after Lawson Tait had demonstrated the practicability of salpingectomy. In spite of a high mortality, surgery was the common method of treating pyosalpinx until after the turn of the century. Belief in the invariable necessity of abdominal drainage after these operations added to the problems of convalescence.

Some uncertainty in regard to all this surgery had begun to be felt when in America the trend to conservatism was accelerated by Simpson's rules defining the conditions under which a case of pelvic inflammation was a safe operative risk. Thereafter for years gonorrheal salpingo-oöphoritis was treated largely by bed rest, the patient being entertained during her convalescence by douches, the injection of protein substances varying in character from boiled milk to killed gonococci and by various devices to produce pelvic heat, bags of circulative hot air or water and different types of electric currents. In 1932, Warren

and Wilson began reporting work with general fever therapy and in 1935 Domagk described sulfanilamide. Apparently a new era was beginning in the treatment of pelvic inflammation.

RADIATION THERAPY

Radiation therapy has affected no branch of medicine as it has gynecology for two reasons: First, the extraordinary susceptibility of the granulosa cells of the ovary to x-ray and radium has made them a most useful agent for affecting ovarian function. The indications, right or wrong of Battey's old castration operation of the eighties have been completely assumed by the pelvic radiologist, who has succeeded also in adding a few new indications of his own. It is, however, in relation to gynecologic cancer, that radiation has had its most revolutionary effect, and it is here that its history can be best traced.

By the year 1890 many operators had undertaken the removal of the uterus for cancer, the name of Freund being particularly associated with the complete abdominal hysterectomy. High cervical amputation and the cautery, a method which persisted for many years (Percy), still vied with hysterectomy as the procedure of choice. At the same time, inspired by the success of Halsted in the treatment of breast cancer, a group of operators were beginning to experiment with more radical procedures (Clark, Ries, Werder). These operations culminated in the extensive abdominal operation of Wertheim (1898) and the comparable procedure by the vaginal approach often named after Schauta. The operability of cases of cervical cancer even when pushed to its limit left from a third to a half of the more advanced cases untreated, while the primary mortality, largely due to peritonitis, varied from 10 to 20 per cent. The operation was, however, a long step forward in increasing the cure rate and it was rapidly taken up in England, France and America.

X-rays were discovered by Röntgen in 1895 and three years later radium by the

Curies. X-ray treatment was applied soon after the turn of the century to uterine cancer (Pusey, Pfahler). The use of radium in America began about 1903 (Abbe), but the most important advance was made by Dominici in 1907 when he published his method of ultra penetrating rays developed by means of a metal filter about the radium. Therefore, the lead in radium therapy remained for some years in France.

The subsequent history of the radium treatment of cervical cancer is one of continuous technical improvement based on increased filtration, prolongation of treatment, combination with x-rays from multiple ports with divided doses and increased voltage. The work has yielded a slow but steady rise in cure rates but has required a constant increase in the cost and complexity of equipment. As a result cancer of the cervix has gradually moved out of the hands of the general gynecologist into special clinics or hospitals of which the Curie Institute in Paris and Radiumhemmet in Stockholm are among the most celebrated. With this concentration of cases has come a world wide effort to study the disease on a common basis, and before the war a special committee of the League of Nations had laid out rules for the statistical handling of results and was publishing under a single cover the figures on cure rates obtained by various clinics following different technical methods. Thus far had one branch of gynecology evolved since 1891 when William A. Baker was reporting sixteen cases of cervical cancer treated by high amputation.

X-ray and radium have had a place but a much less essential one in the treatment of cancer of the corpus and of the ovaries, where surgical removal is still the essential point in therapy. Radiation has found a definite indication in the treatment of fibroids, but this is limited by the associated destruction of ovarian function. In this respect a swing back toward surgery has been observed in the last few years, perhaps as a concession to the greater value

that the new physiology has bestowed on ovarian function.

GYNECOLOGIC SURGERY

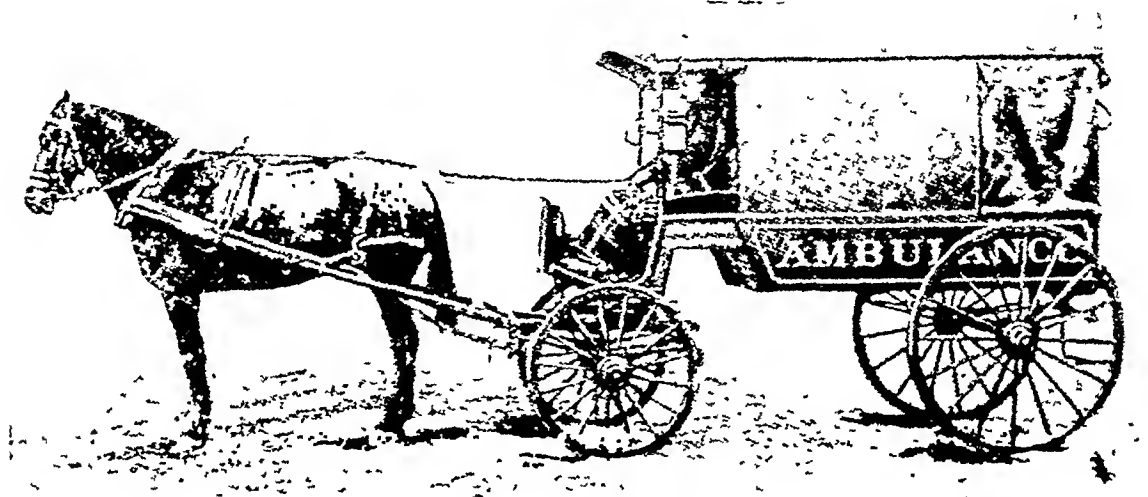
Although the outlines of modern gynecologic surgery had been sketched a half century ago, advances of considerable importance have none the less continued to be made. Many of these are the forward steps common to all surgery. At the beginning of the period many operations were still done in the home, a practice now all but forgotten in the larger centers. During this period too preoperative preparation was developed and anesthesia became an art. Gloves and face masks appeared. Instruments became fewer in number and were better constructed. Suture material improved in sterility, lightness and durability. Drainage of the abdominal cavity ran a difficult course and finally disappeared as a common practice. Laboratory tests to measure the physical status of the patient, blood pressure, blood counts, blood chemistry, electrocardiograms and a dozen other procedures were developed to guard the patient against unknown risks. These innovations have continued to reduce the mortality rates from gynecologic operations almost to the point of vanishing.

In spite of the greater margin of safety in surgery, conservatism has been a steady trend in gynecology. A brief review of the history of various gynecologic operations suffices to prove this point. The radical operation for uterine cancer has all but been forgotten since the advent of radium. Salpingo-oöphoritis is now subjected to surgery in only a small fraction of the cases and then under circumstances which remove most of the risk to the patient and the excitement to the surgeon. Many fibroids are treated by radiation. Retroversion is conceded to be a tenable position for many uteri. Cystic ovaries are respected as never before and even the cervix is now cauterized or coagulated instead of being amputated.

There have been a few new and important operations. The surgery of uterine

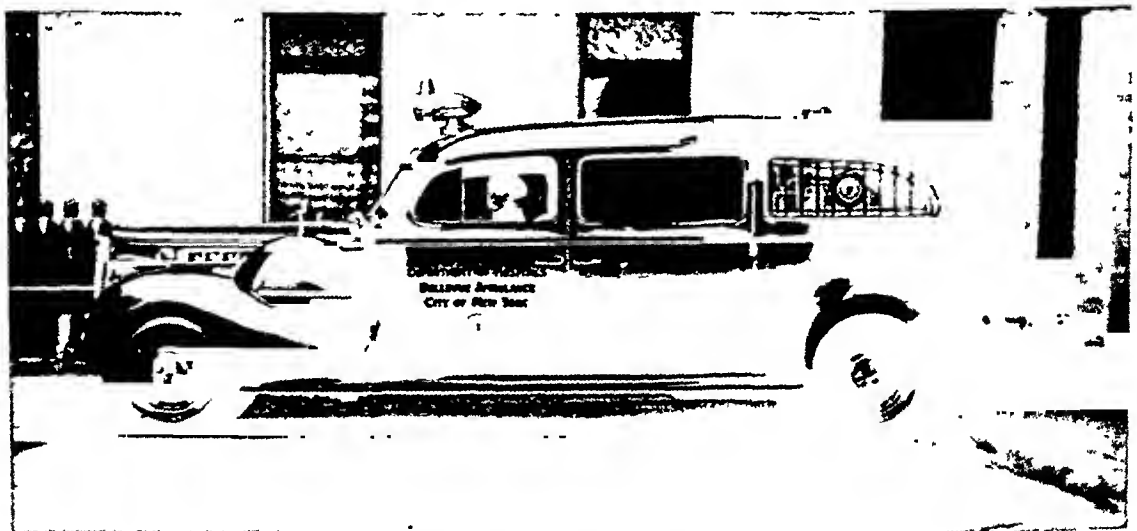
prolapse, as an example, has been developed almost entirely within this period. Before the nineties prolapse was handled by ventrosuspension, by building up the

in the interposition operation of Watkins. This operation was very popular until partly superseded by vaginal hysterectomy with plication of the broad ligaments



The First Ambulance in the World

This first ambulance in the world was initiated into service by Bellevue Hospital, New York City, in 1869. It was designed by Dr. Edward B. Dalton who was a Colonel during the Civil War and worked as an Army Surgeon along the Potomac River.



Bellevue Hospital's Ambulance Today

perineum to afford the resting place for a pessary or by the Le Fort operation. The control of descensus by plastic work on the anterior wall and by the elevation of the bladder upon the cervix, the beginning of modern operations for prolapse, was the work of Hadra in 1889 and Sänger in 1892. In America, the principle of upward displacement of the bladder later culminated

(Mayo). In England, a procedure known later as the Manchester operation was developed by Donald and Fothergill and brought to America by Shaw in 1933 after it had been common practice in England for many years. This operation made finally clear the prime importance of the parametrial tissues in the support of the uterus, and was therefore essentially different in

principle from the various bladder displacing operations. At present these various methods of approach to the problem gradually seem to be finding their own special sets of indications.

Many other surgical procedures might be mentioned. A variety of methods were developed for suspending the uterus (Ols-hausen, Gilliam, Webster, Baldy, Simpson, Coffey). A valuable operation for cure of endocervicitis was devised by Sturmdorff, although this in itself was less important than the discovery that the proper use of the cautery would usually cure an infected cervix without surgery. The construction by Rubin of an instrument for determining the patency of the tube revolutionized the treatment of sterility and stimulated the working out of a variety of tubal plastic operations.

PAST FAILURES AND THE FUTURE

If one were looking forward from the nineties, one would have hoped that something might have been accomplished in places where no progress has been made. In spite of a new remedy every year, dysmenorrhea is as difficult to treat as it was fifty years ago. Only a quarter or a fifth of all cancer cases live for five years. The psychologic adjustments of marriage, the disorders of the sexual function in the strict sense, are as unsolved, almost as unexamined, as they were in the time of Thomas and Emmett.

To attempt to look into the future is to risk one's peace of mind, and it cannot be said that the prospects are entirely bright for the independent specialty of gynecology whose early history was for a brief period almost that of all surgery. Gynecology has unfortunately no highly technical instrument such as the cystoscope with which to defend itself and it is threatened from many directions. The now standardized operative procedures, such as the hysterectomies and oöphorectomies, are ready to the hand of the general surgeon. The urologist is recapturing the urethra and bladder. Sex hormone endocrinology has become the

field of special interest of several prominent teachers of internal medicine, so that hot flushes are no longer the special property of the expert on diseases of women. The radiologist is reaching the point where he can handle cervical cancer with scarcely a gynecologic consultation. Dysmenorrhea and some like conditions are looked upon with interest even by the psychiatrist. What is left is often just enough to occupy the time of the busy obstetrician between deliveries.

With the great days of advance in pelvic surgery past and many of the mysteries of the specialty made apparent to the outsider, it is almost evident that the hope of gynecology is in close union with obstetrics. History has always recognized the close relationship of the two branches and modern trends in education as well as in the organization of medical practice, as typified by the American Board, promise still closer union. As social conceptions continue to increase their hold on the public and medical mind, such a broad specialty which has as its responsibility all the problems of human reproduction, whatever the techniques employed, cannot but maintain its high place in the world of medicine.

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FIFTY YEARS OF ORTHOPAEDIC SURGERY

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ORTHOPAEDIC surgery had its development from the same humble origin as did the entire profession of surgery and, like surgery, its practice was quite in accordance with the facilities which science provided at that time. Because of the thorough knowledge of mechanics and the efficiency of the general equipment, and also because of the limited field of surgery, the treatment of those conditions which are now regarded as orthopaedic was very largely mechanical and was in accordance with the thorough knowledge of mechanical principles. Treatment was necessarily limited, however, because of the meager knowledge of pathology and of the character of bone and joint disease, and surgery permitted only a rather limited excursion out of its recognized field. Because of this, it was very largely in the hands of brace-makers, who were many times very skilled in the application of mechanical principles to joint diseases, deformities, the defects of paralyses, etc.

One of the early signs of recognition of the need for segregation in this kind of work was the formation of hospitals devoted to the care of these orthopaedic patients. This was seen early in Europe, where many clinics were started independent of the public hospitals and developed into important and large institutions for treatment. The earliest hospitals in the United States devoted to this special work were in New York, established by the pioneers and were distinctly private institutions.

At first the work in all institutions was confined almost entirely to the mechanical treatment of the diseases and conditions. Tenotomies, evacuation of abscess formation in a large number of tuberculous joint diseases, occasional excision and the forceful manipulation (mechanical) of club feet comprised the general scope of their surgery.

Later, special hospitals were established for the treatment of these orthopaedic conditions, and now every city of importance has its orthopaedic hospital and the large hospitals have departments devoted to the care of orthopaedic cases. Since the scope of treatment became so greatly enlarged, these departments in the hospitals are now very largely operative; and with the development of the operative side of orthopaedic surgery, mechanical treatment by braces, etc., has gradually become less prominent although not less important.

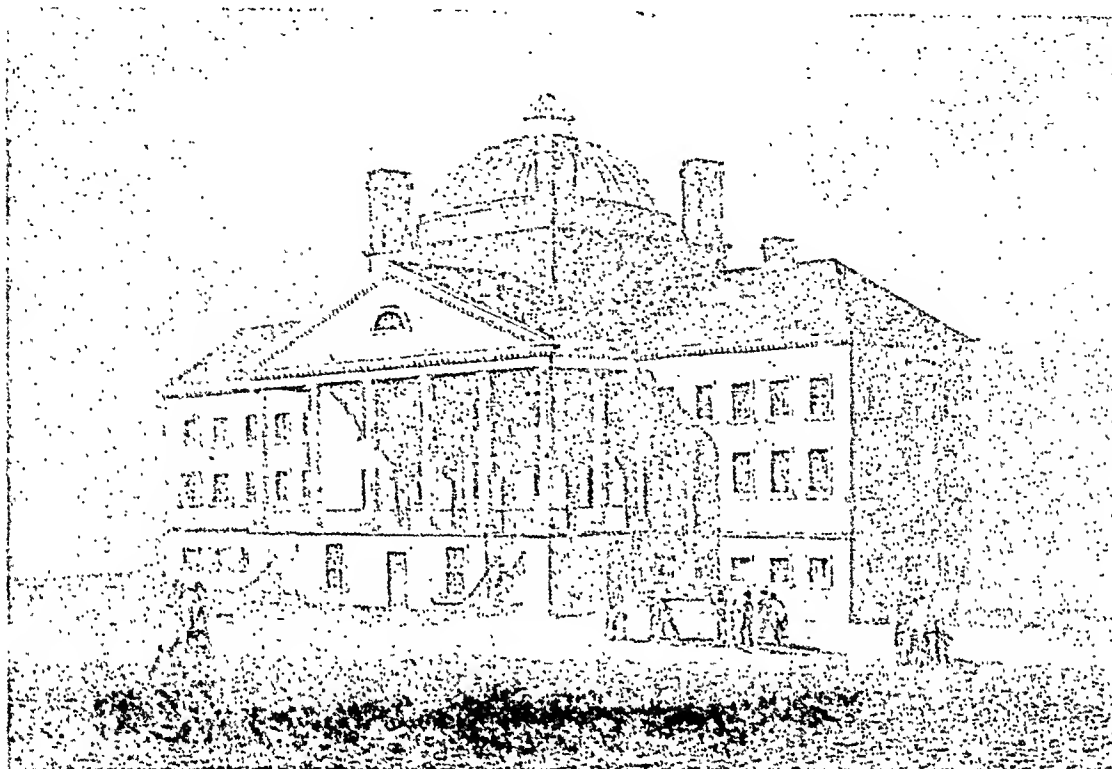
In this pre-orthopaedic period, the use of appliances was developed to meet clinical demands, although guided by the very limited knowledge of pathology, etc., and it was not until more was known about the progress of disease, and also not until the demand of the people had become much more insistent for improvement in technique and for greater efficiency in the treatment of this group of patients, that the profession began to interest itself in special branches of medicine. The mechanical treatment of these conditions in the early periods gradually merged into a recognized department of medicine.

It took men of strong convictions, determination and foresight to be the pioneers in this evolution, and it required these qualities to take advantage of the increasing knowledge and to apply it toward the refinement of methods which, up to that time, had been limited and somewhat crude.

The conditions which, in general, were recognized as comprising the scope of orthopaedic surgery were the tubercular joint diseases (other forms were not, at that time, differentiated), some of the chronic rheumatic affections, deformities—congenital and acquired—including deformities and defects following infantile paralysis,

flatfoot and many of the malunited and nonunited fractures. The added interest of these men in the treatment of patients

following antiseptic surgery, which increased the facilities and the knowledge of bone processes, and which has almost



The Bulfinch Building of the Massachusetts General Hospital.

with tubercular joints which, at that period, was mainly mechanical, evidently stimulated the refinement of the apparatus and brace treatment of the other conditions which were coming under their guidance, and this method of therapy fifty years ago reached a high degree of proficiency and excellence, both in the intelligent employment of the principles of mechanics and in the types of apparatus used.

This probably prepared the stage for the next step in advance, which came with the advent of the new principles of antiseptic surgery, which opened up a new field of work. The advances made in the treatment of this group of conditions were dependent upon many factors, but the first and most important must be considered as those advances in surgery which enlarged the field of operation and allowed a precision in obtaining results. Heretofore, operations had been limited mainly to tenotomies and those of like magnitude. The other factor in the enlargement of the scope of orthopaedic work and in the success of the treatment

revolutionized diagnosis and has added precision to the treatment, was the *x-ray*. Probably the influence of the *x-ray* was felt in the study of bone earlier than in any other department of medicine, and at first it was thought that its use would be limited to bone conditions; but, combined with the results of the new field of research opened up by biochemistry, it has made as complete a revolution in the scope of the understanding and the capacity for treatment as in any other department of medicine or surgery.

Surgery of the bones and of the cavity of the joints, as well as of the cavity of the abdomen, was not regarded as within the limits of safe or justifiable surgery. Even the abdominal cavity emerged from this "No Man's Land" before the joint cavity yielded to antiseptic surgery. As has often been the case in the history of medicine, increased knowledge which came with the gradual development of medicine and surgery allowed the more intelligent and wider use of methods which had previously been

carried on only in crude form; and since these advances were recognized throughout the whole world, we find the development appearing almost simultaneously in orthopaedic surgery in places widely separated.

It is often interesting to observe how a new interpretation of disease, a conception of pathologic processes and departure from the conventional methods of treatment may appear in different parts of the world at the same time. Discoveries in medical science are so widely distributed, that advances made possible through this added knowledge and increased facilities for study and diagnosis are recognized by workers all over the world at the same time, and the developments which mark progress are often reported simultaneously by observers in different parts of the world. Claims of priority are often but an indication of the stage of development that medical science has reached.

The need of careful observation and study, in place of the more elaborate means of investigation and laboratory proof of today, developed a group of men who were keen observers and who were able to interpret with remarkable accuracy the clinical evidence of disease. It is not that the medical and surgical men of today are less resourceful than were those in the early periods, but, rather, the limited means at that time demanded the fullest use of the facilities at hand, and developed men of unusual courage to invade the "No Man's Land" in surgery in their attempts to provide relief. There was a lack of feeling of security in the advances first made, that, with the facilities and laboratory aids of today, is no longer present. Laboratory and other like means to aid and to guide in diagnosis were few, and these men had the capacity for quickly sizing-up the essentials with amazingly accurate judgment. They were masters of the means at their disposal and of the facilities which medical science of this period afforded to them; and in the application of this knowledge to the individual, they possessed a capacity for clinical judgment often lacking now, when

dependence on complicated and elaborate means of diagnosis tends to limit greatly the personal equation, which supplies the ability to estimate the relative values of clinical and laboratory evidence and to adapt it to the individual. The constant employment and dependence on accurate scientific data in detecting morbid processes often leaves the application of the personal equation to the individual somewhat of a detached factor.

The ravages of the tubercular diseases of joints were causing insistent demands for more accurate and more efficient methods of treatment, which stimulated the inclusion of other conditions whose demands, although important, were, perhaps, less insistent. Hilton, in his book on "Rest and Pain," had brought into prominence the doctrine of rest as essential for repair and this doctrine at that time enjoyed practically universal acceptance. A few men with more than the ordinary foresight and intuitiveness recognized the opportunities. In America, there were two men in particular of strong convictions and with decided opinions who stood out pre-eminently as the leaders in this movement. It is to these men that credit must be given freely for bringing the treatment of these diseases into a position of a recognized specialty. Each was the strong advocate of his own method of obtaining this necessary rest and, although their methods were different, they were both working toward the same end. The efforts of these pioneers were met, as were other departures in medicine, with definite opposition, but their belief in their chosen work and their persistence never wavered. This opposition may have retarded the rapidity but it served to strengthen the growth of the specialty; for the slower growth allowed it to be woven more securely into the warp, and it became an integral part of the domain of surgery instead of a side issue.

In these early periods, practically all of the joint diseases were considered tuberculous, and it was not until much later that it was proved by adequate facilities of

diagnosis that many of the reported cases in which different methods were employed were other forms of infection from other bacilli, chemical toxemia, etc. Progress in surgery has made the problem of diagnosis in early affections of joint disease increasingly difficult and often possible only after long study and investigation. The patient, on the other hand, has reaped the reward that science has bestowed.

Because of the prevalence of tuberculous joint disease, the work of these two men was largely identified with this problem, and in following out the ideas of Hilton they established the two methods or means of treatment. One of these obtained rest by the use of plaster of Paris, and the other, by the use of braces combined when possible with traction. Both men were of unusual intelligence and skill, and they brought these two methods of treatment of joint diseases to the highest degree of excellence—almost to perfection. Others have made claims of priority, whether with justice or not, in the use of these forms of treatment; but these two men demonstrated these methods of attaining rest by fixation and by traction and made them available to the medical public. Both have had and continue to have their strong adherents in this and in foreign countries.

With the increased knowledge of disease and with the added facilities for study and for diagnosis, the general acceptance of the aim in the treatment of these conditions has gradually eliminated discussion in regard to the means by which it should be obtained. At that early period the cure of tuberculous joint disease was sought in long continued rest with the endeavor to retain some motion. Probably it is in this object of treatment that the most radical change has been apparent, for time has demonstrated that the cure with slight motion of tuberculous joints in which destruction of the joint areas has occurred, is not always safe in later life, and it is, therefore, generally accepted that bony ankylosis of a tuberculous joint assures the most dependable result in after-life. Cures were

obtained only after long, persistent, conservative treatment, often with continuous sinuses and copious discharge in the more severe cases. Amputation was not an unusual final procedure to eliminate the disease or to save life. Excision of the involved areas was practised for a time, with some, but not marked, improvement in the results, and the after-treatment was necessarily continued a long time. On the other hand, it must be remembered that the mechanical treatment was frequently so efficient that satisfactory results were obtained in a surprisingly large percentage of cases.

The estimate of what constitutes a cure of destructive tuberculous disease has undergone a definite change in the past two decades. Relapses of cases supposedly cured were continually encountered, due to the stress of the demands of adult life. Motion in joints, which have been the seat of previous destructive disease, even after long periods of quiescence must be considered as frequently being a source of danger. The increased knowledge of the unsafe condition of partly cured areas which have been the seat of destructive disease has resulted in the general acceptance that bony ankylosis affords the most dependable, although perhaps the least convenient, joint. By anticipating Nature's best result and producing an ankylosis by operation at the proper time, early in the course of the disease, months and years of conservative treatment are eliminated and a more dependable cure is obtained. That the age of the patient and the stage of the disease are both questions which still require experience is a generally accepted opinion, but the method is already fruitful of definite progress.

No greater change has been recorded during the past fifty years than that of the prevalence of tuberculous joint diseases. Tuberculosis formed the bulk of the practice of orthopaedic surgery in the early days of the specialty, both in the clinics and in the private practice of orthopaedic surgeons, and produced the severest types of

cases with extensive disease. During the last decades, the prevalence of tuberculous joint disease has so diminished that it now forms only a small part of both hospital and private practice, and the large group of suppurating cases requiring daily dressings no longer constitutes the larger part of the daily hospital routine. The change in this picture has come because of several important factors: the elimination of the source of infection from bovine tuberculosis, improved hygienic conditions, recognition of the danger of contact contagion, the beneficial effects of heliotherapy and the recognition of the general rather than the local character of the disease, all of which have contributed to the extraordinary diminution in its prevalence.

Progressive workers in this field of surgery have taken quick advantage of the opportunities to develop this field of work which modern surgery and the x-ray have furnished. The growth in its scope and efficiency is illustrated by a brief survey of some of the more important conditions which come under the care of this group, and the changes indicate the steps or the stages through which they have passed in the progress.

The surgery of joints presents one of the more striking examples. Arthrodesis, at first interarticular, later extra-articular, was the first and perhaps the least difficult procedure, particularly in its contribution in the extra-articular arthrodesis applied to tuberculous joints. The mobilization rather than the immobilization of joints met with a greater obstacle. A demonstration of this is seen in the gradual evolution of the operation for arthroplasty, beginning with crude and at that time courageous attempts to prevent the union of freshly denuded bone surfaces by the interposition of some material. Among the first of these materials was celluloid; later slowly absorbing membranes, including fascia lata were used with some degree of success, and now with the increased knowledge and understanding of nonirritating alloys, metal between freshly denuded bone surfaces is employed.

In the early periods, Scoliosis was a subject which developed a great deal of interest and occupied the attention of a large number of orthopaedic surgeons. This deformity had intrigued some of the most accurate and intelligent investigators, particularly in the study of its etiology and development. The interest in scoliosis also stimulated attention to the posture of children and extended to the care and treatment of growing children in school.

The treatments for these two conditions were very often grouped together. At first the treatment was necessarily limited to the employment of mechanical appliances and the different forms of physiotherapy, including gymnastic exercise. Both the mechanical and physiotherapy treatment attained a high degree of efficiency, probably because in this pre-operative period, treatment was necessarily restricted to these methods. A great deal of dependence was placed on the beneficial effect of exercise and this form of treatment was highly developed. There were many schools of treatment by gymnastic exercise, the principles of which were directed toward the correction of the curves as well as toward readjustment of muscle control. As in other affections, this treatment was most efficient in the milder forms, but the severer cases proved to be definitely intractable.

It was at this time that the principle of primary correction of rigidity of the curves by both forcible physical exercise and mechanical appliances was advocated and developed to a high degree of efficiency. This marked an important step in the progress of the treatment of this difficult problem. For this purpose, strenuous exercises were used, but more dependence was placed upon and more definite results were obtained by the various mechanical devices, the force of which was directed toward producing traction and de-rotation. The amount of force which it was found practical to use by this means—since the amount and direction could be controlled accurately—was remarkable.

The use of plaster of Paris jackets applied with mechanical aid to obtain a forcible de-rotation was, perhaps, one of the important steps in the development of more vigorous methods, and was distinctly popular for a time. It certainly stimulated a renewed interest in the treatment of this condition which had begun to wane. The continued use of this principle has developed the employment of jointed plaster of Paris appliances, which allows the treatment to be carried on with the other forms of therapy, such as exercise, etc. The difficulty of treating the more severe cases and the urgent need to prevent the increase in some of the more pronounced, intractable cases—particularly those associated with paralysis, usually infantile—as well as to prevent the development of the deformity in some of the younger patients, stimulated the more active treatment by fusion operation, and is a demonstration of one result of the added facilities offered by the advent of antiseptic surgery.

Fusion by different types of operation in order to solidify an area subjected to stress by the superincumbent weight and an uneven musculature was first performed in 1931. This method should not be considered as entirely new in principle, but rather a method grafted on to the older and recognized forms of treatment, in order to shorten the treatment and give more definite results in those cases which are not amenable to the other conservative methods. The age of selection and the security on which dependence can be put in the after periods, etc., have not yet been definitely agreed upon by all observers. The strong advocates are not of uniform opinion on some of these important questions, but evidence is continually collecting from the experiences of these observers which will eventually lead to uniformity. The older forms of treatment are still actively employed.

The treatment of Congenital Dislocation of the Hip is an example of what has been accomplished in the care of this difficult problem, particularly by the persistent

endeavors of comparatively few who firmly believed in the possibility of its solution. At that time, this condition was held to be one of the most difficult to relieve and one of the most impractical to correct. Reduction was by no means certain and retention was less so. Today the care of this condition is approached with confidence, and the methods of treatment, made practicable through the opportunities of surgery and the guidance of the x-ray, have resulted in the development of means to include the older cases in the group, and to give relief at least, if not cure, in the majority of even these cases.

The solution of the problem of actual reduction was sooner achieved than the agreement on the choice of methods, and the recognition of the later abnormalities developing in the joint as a result of the trauma which is a part of the treatment with many of them. During the early practice in the reduction, the manipulative methods were universally in vogue, and found strong advocates of the different procedures for the replacement and for the general technique of after-care. The results showed only partial success, and the failures developed earnest advocates of open reduction even in the younger cases, which proved to be a step toward the recognition of a more secure means of replacement and of retention in the large percentage of cases. They claimed for this method less trauma and a greater surety of replacement and retention. Each of these groups contributed toward the sum total of the solution of the problem, and has made possible a satisfactory agreement in regard to the general conduct of these cases. The possibilities of modern surgery and roentgenology have yielded the greatest contribution to this present satisfactory solution of the problem.

A study of the clinical course of these cases operated on by manipulation, with its traumatic technique or by open operation, shows the degenerative changes of misshapen femoral heads, etc., and this has been the influential factor in the gradual adoption of the present methods of dealing

with this group of cases. These late results were not recognized for many years, and the knowledge of these final results probably was the important factor which led to the more frequent adoption of the open method for the difficult cases as being more definite and less harmful in technique. Manipulation is used but is guided by the knowledge of the later possible degenerative changes as a result of undue trauma. Open reduction, with improved avenues of approach, may be resorted to earlier. Modern surgery, aided by better understanding of joint conditions, as shown by the x-ray, has extended the treatment to older and adult cases, mainly by the "shelf" method, which affords an area of impingement for the head, thus allowing firm weightbearing even with a definitely imperfect acetabulum.

The frequent and severe epidemics of Acute Anterior Poliomyelitis have furnished an extensive field for research and experience in the treatment of the defects which supervene on these paralyses. First stimulated by the individual interest, and later aided by societies sponsored by private interests, and still later by State and Federal organizations, the advantages which have been brought to those whose capacity has been impaired by the results of this disease, have been one of the most remarkable phases in the results of its treatment.

The special benefits which have come to the patient with paralytic defects and deformities are the result of the more accurate technique of tendon transplantation, the greater insistence upon the preservation of the integrity of the tendons and their sheaths, the more careful choice in the selection of cases for the transference and the greater caution and better judgment in selection of the age for operation. Astraglectomy, one of the earlier radical operations, proved its value in a large number of cases before other bone operations were advocated. The stabilizing operations, used either alone or combined with tendon transplantation, afford security in the absence

of sufficient muscle power and in the prevention of the development of deformity from mal-weight-bearing and mal-balance of muscle pull. The operative field in later years has offered the greatest opportunity for more efficient methods, just as the mechanical treatment, which had so much more attention in the pre-operative period, became highly developed and efficient. The insistence on rest and the avoidance of overfatigue of weakened muscles during the active treatment period, particularly in the physiotherapy which accompanies all treatment of these cases, indicates the broader and more comprehensive viewpoint in meeting the problem of treating this complex condition.

There is no subject which has recorded a more complete change than that which is evident in the methods and in the success of the treatment of Fracture of the Neck of the Femur. The literature of fifty years ago gave only a most discouraging outlook for a successful result and little encouragement for the future. Union was almost the exception. The first advance was made by the introduction of the abduction method of replacement and retention in plaster, which was a radical departure from the usual treatment and did not follow any definite principle; and this marked a distinct beginning in the progress which has continued until today, when the results are now as reliable as in almost any surgical procedure. The time of treatment is reduced to a much shorter period, the patient is allowed ease during this shortened period of treatment and is given the assurance of a reasonable degree of success, even the aged. Recent factors of importance are the more accurate method of reduction, the more precise means of detection of the reduction and of the retention, with which the percentage of successful results has steadily risen.

The greater advance which has nearly revolutionized the definiteness of treatment is a result of the opportunity which modern surgery has afforded for operation—by the

opportunity to employ the open method, first to obtain fixation by means of the graft. It was in the older, ununited cases that this improvement first took place. Retention by nails was first performed many years ago by the simple spiking, and the renewal of its use marked the beginning of the most important advance in the surgical treatment of this injury in the fresh as in the old ununited cases. In following this principle, many forms of nail fixation of the head were used by the investigators in this special subject, varying in number from one to several, and in size from the large spike to the Kirschner wire. Both the results obtained and the shortening of postoperative recumbency from months to days justified the endeavors.

The development of nonirritating metals—both in the fresh and in the older cases—the use of the flanged in place of the plain nail and the variety in the types of screws used for the fixation of the femoral head have brought the treatment of this injury to a procedure of precision and of definite results. The type of device for fixation and also of the many ingenious mechanisms used for guidance in placing the metal are still matters of individual choice and of familiarity with the method; but excellent results are obtained by them all in skilled hands, and in place of recumbency of from two to four months, the patient is often allowed out of bed in a few days.

The World War brought into sudden demand the resources for the care of these bone and joint diseases and injuries, and one that required all the experience available to care for these conditions in bulk. All surgery responded, and orthopaedic surgery was organized to develop the necessary equipment to meet the demands upon it both in personnel and in materials. The different departments under which the work was carried on responded to the call, and the mutual working-out of the problems resulted in a close relation and cooperation and helped to establish the accepted position of orthopaedic surgery in the medical field. The recognition of the

contribution which general surgery had to give to orthopaedic surgery and the special contribution which orthopaedic surgery had to offer to general surgical practice have resulted not only in the development of more accurate and satisfactory methods of treatment but have added greatly to the successful care of these cases.

With the very active development of the work in industrial surgery, a large part of this traumatic work is directed toward the care of injuries, particularly of the bones and joints, and experience during the War has aided, in a large degree, the development of this specialty. The close similarity between the conditions and the methods of treatment in the so-called "orthopaedic" and so-called "traumatic" cases has resulted in an enlargement of both of these departments of medicine. This has already tended toward the drawing of less fine distinctions in the scope or the limits of the specialty and toward the acceptance of the understanding that the science of surgery has the responsibility of caring for the conditions requiring attention, and that the duties of one of its special departments are to produce an equipment and a personnel, fitted by study and experience, to give the best treatment to the cases which are relegated as coming under its care. This cooperation insures the grouping of the best from all the facilities which medicine and science are able to bring to the benefit of the patient.

The medical societies have been one of the most beneficial influences in the development of the character of the work in the formative period and in the recognition of the necessity for segregation to a special group much of this department of surgery. In 1887, a small group of orthopaedic surgeons in the eastern states formed the American Orthopaedic Association, which proved to be an important move in the establishment and recognition of orthopaedic surgery as a specialty, and in the formulation of the group of cases which was considered as coming under the scope of this department. It furnished an oppor-

tunity for the advocates of the different methods of treatment to discuss their theories and ideas in that early period of the specialty when the general rules of procedure had not yet been established and opinions were widely separated. The membership of this charter group consisted of thirty-five surgeons and was limited to those exclusively engaged in the practice of orthopaedic surgery. The wisdom of its organization was demonstrated by its immediate success. The membership was limited in numbers in order to confine its interests to purely orthopaedic problems at its annual meetings, which were held in the home city of its president of that year. Expansion in numbers and in territory marked the increasing interest in this group of diseases and the greater recognition of its need. With the increasing number of orthopaedic surgeons, the limit of its membership was gradually raised, and at the present time there is an active membership of 147 distributed throughout the United States and Canada. Its membership is still limited to those who confine themselves to the practice of this specialty.

There was a rapidly increasing number of surgeons who became interested in the problems of bone, joint and traumatic surgery, and the development of industrial surgery added very materially to this list as well as to the need for thorough study of the problems connected with these injuries and the conditions which followed them. There was evidently a desire by a large number of these men all over the country for the opportunity to attend meetings in which problems of this character were being discussed. In 1934, to meet this demand, the American Academy of Orthopaedic Surgeons was organized with a charter membership of 425. The members of this organization were not necessarily those who limited themselves exclusively to the practice of orthopaedic surgery, but were those interested in bone, joint and traumatic surgery as well as purely orthopaedic problems. This move met with an immediate response, for it presented an

opportunity for a large number to hear the papers which were delivered and to benefit from their enthusiastic meetings. The Academy has since had its annual meetings with increasing attendance and increasing membership, and has played an active part in the development of the position of orthopaedic surgery during the past few years. It has now an active membership of 641.

In 1934, the American Board of Orthopaedic Surgery was incorporated. It was organized on the same plan as other departments of medicine which had previously established similar committees. The duty of this organization is to designate the necessary requirements for recognition in orthopaedic surgery and to standardize these requirements for membership in the two recognized societies. Its officers are members of the American Orthopaedic Association and the American Academy of Orthopaedic Surgeons, and this Board conducts annual examinations for membership. It has now been established that all applicants for membership in either of these two societies shall be required to have passed the Board examination in order to be accepted as candidates. Those who pass may then be elected in accordance with the requirements established by each Society.

During the last two decades, the formation of societies which have for their object the provision of treatment for crippled children has represented one of the activities relative to this specialty. With the increased amount of interest and added possibilities for treatment of this group of crippled children, segregation into special groups became necessary to carry on the large bulk of the work and to provide special means of treatment for the large number of cases.

The first society of this kind originated in 1931 and its object was to bring to crippled children the means of treatment for their physical defects and to provide for their education and occupational training which might be used for support later on. It

made no attempt to treat or to provide any special means of treatment, but rather to bring the children to those institutions already organized where this could be carried out. It was found that a large number of cases were throughout the country, and a survey made in different regions disclosed a large number who had never had an opportunity for treatment, either because of ignorance of the opportunities or because of inability to avail themselves of them. The work of this society grew rapidly and it has now become an international association.

This society probably stimulated the formation of other societies with like objects and like methods, so that there are now many societies scattered throughout this country, some independent and others connected with the communities, working in conjunction with recognized institutions and also with the Federal Bureau which was established in 1935 to aid in the care of crippled children. The same plan has been operative in many foreign countries, usually working with the national societies. The whole movement originated in response to the recognition of the great need for and also lack of care among this group of individuals, and also of the necessity for providing some means of bringing into contact with the opportunities for treatment which already existed a very large number of those individuals in all parts of

the country for whom no treatment had been available. This lack was either a result of the ignorance of relief that was available to this group of cripples or because of the inability of the parents to provide the opportunity for them.

As with other specialties, there has been much discussion in reference to the scope of conditions to be grouped under this department. To confine the borders or limits in this way is not satisfactory nor is it possible. In orthopaedic surgery there can be no anatomic grouping as in some of the special departments of medicine and surgery, nor does it include all of the infections of any component structure (such as bone, etc.), but it deals rather with principles of treatment and with the correction of faults and defects which involve the coordination of many parts of the entire body. The specialty today implies special knowledge and equipment which will enable an orthopaedic surgeon to care for in the most efficient way and with the best ultimate results the conditions which he accepts to treat. So often the task includes the working out of a problem involving several stages requiring different forms of treatment and demanding long-continued care rather than following a recognized surgical procedure. The horizon is limited by the personal equipment and skill, gained by special study and experience, that the orthopaedic surgeon can bring to the task.



FIFTY YEARS' PROGRESS IN UROLOGY*

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TO do justice to the remarkable advances made in urology during the past fifty years is an impossible task. There is no branch of medicine in which embryology, endocrinology, comparative and regional anatomy, bacteriology and other forms of laboratory investigation play so important a role. The *armamentarium urologicum* with the developments of cystoscopic instruments is a vast field in itself. The scientific papers on urologic subjects comprise hundreds of thousands of items. This survey, confined within the scope of a journal article, cannot include more than a small percentage of even the important papers. I am aware that many which should have been discussed have been missed.

It seemed advisable to ascertain what the status of urology was before the period under discussion. It has been portrayed in an encyclopedic manner in Volume 1 of Prince Morrow's "System of Genito-Urinary Diseases, Syphilology and Dermatology." The first volume of 1,074 pages of this epoch-making System (1893) contains exhaustive treatises by thirty-two of the leading genito-urinary surgeons in America. The majority of the writers were men of distinction and occupied professional chairs in the great medical schools of America. In the space allotted to this article, it is impossible even to refer briefly to the contents of this volume which has played such an important role in the development of urology in this country and which, in my early days, furnished me with a great inspiration. It is still a fountain source of information which should make it a "must" reading for all students of urology.

The chapter on diseases of the penis

came from the pen of our revered Ramon Guiteras. Only minor operations were done. Cancer was treated mostly by amputation; extensive resection and removal of the glands were not even considered. Circumcision occupies many pages and balanoposthitis many more.

"Diseases and Injury of the Urethra" by F. Tilden Brown, one of the greatest of early cystoscopists, is still interesting reading and applicable to modern urology. Duplay's operation for hypospadias is given in detail. His methods are still of fundamental importance and do not differ very greatly from modern practice. Thiersch's modifications of Duplay's work for hypospadias and epispadias had already appeared and profoundly affected the surgery of these conditions for many years. Rupture of the urethra was handled effectively by perineal operations. Suturing of the severed portions of the urethra was advocated when it occurred in front of the triangular ligament, but apparently no operative attack was considered when the rupture was behind the triangular ligament at the juncture of the membranous and prostatic urethra. Suprapubic drainage was apparently all that was thought of at that time. For strictures and fistulae the surgery was good and not very different from that of today.

Although the gonococcus had been discovered only eleven years before, great progress had already been made in the bacteriology of the urinary tract and anti-septic treatment. Deep seated lesions of gonococci were discussed by George Emerson Brewer in a classical chapter. The chapter by William K. Otis on chronic gonorrhea is still important reading.

* From the James Buchanan Brady Urological Institute, Johns Hopkins Hospital.

The endoscopic pictures in color which accompany Herman G. Klotz's chapter on endoscopy of that day are still interesting.

Seventy pages are devoted to stricture of the urethra by J. William White. With lovely illustrations and excellent surgical advice, it leaves little to be added by moderns.

William T. Belfield discusses "Diseases of the Prostate." This is an important article by the father of modern prostatectomy. He devotes many pages to local treatment, catheterization, etc. He says that in a considerable number of patients palliative measures fail to avert constant suffering and a fatal result. These cases were formerly regarded as beyond surgical cure; aside from the relief obtained by suprapubic puncture, they were abandoned as hopeless. As Belfield says:

The theory of the radical operation assumes that the cause of chronic retention is mechanical obstruction by the enlarged prostate; that such prostatic obstacles are capable of removal; and that after such removal the bladder will resume its function of voluntary evacuation.

These propositions have been denied by three of the foremost among living genito-urinary surgeons—Thompson, Guyon and Socin, but Guyon made his first attempt [to remove an obstructing prostate] in July, 1899 and found a prostatic growth readily removed. The accumulated clinical observations of the past five years prove that these traditions of the earlier surgeons, upheld by Guyon and Thompson, which have dominated surgical opinion and practice, must be restricted to a minority only of prostatitics; for it is clearly demonstrated:

That there is a larger class, entirely distinct from these, in whom the failure to evacuate the bladder is due in no wise to degeneration of the vesical muscles, but solely to the mechanical obstruction offered by prostatic growths; since the removal of such obstacles has been followed in over three fourths of the cases previously dependent upon the catheter by restoration of the vesical functions.

That the prostatic obstruction is usually, contrary to the opinions of Guyon and Thompson, of such form as to permit excision, is shown by the fact that in four fifths of the

cases of suprapubic incision such obstacles were found and removed.

It is proved that in many prostatitics the source of the evil is to be sought not in sclerosis or senile degeneration of the bladder, but in mechanical obstruction by prostatic tumors; that these tumors are not a product of sclerosis, nor of senility, nor even limited to advanced life; . . . that these tumors are in most instances susceptible to removal; and that in such cases a well-executed radical operation restores voluntary urination.

It is indisputable, however, that in many prostatitics of advanced age arteriosclerosis and degeneration of the vesical walls coexist; the contractility of the bladder is seriously impaired, and removal of the prostatic obstruction fails to restore voluntary evacuation of the organ. It is important to differentiate between the obstruction and degenerative factors.

Prostatic obstacles to urination have been attacked by four routes: (1) urethra, Mercier, Bottini; (2) perineal incisions, Harrison, Keyes, Dittel; (3) suprapubic cystotomy, Belfield, McGill; (4) combined perineal and suprapubic incisions, Belfield. [Belfield shows that Mercier's and Bottini's methods are unsatisfactory.]

Perineal urethrotomy has been employed in some forty cases as the avenue of access to the prostatic obstacle. Small median tumors (middle lobes); transverse overgrowths (bars at the bladder neck) have been incised and excised; even lateral masses of considerable size have been enucleated (Wishard). Yet many cases are not capable of satisfactory treatment by this incision; the elongation and rigidity of the prostatic urethra prevent complete operation or even exploration at the bladder neck.

Suprapubic cystotomy seemed at first to fulfill every requirement. . . . Prostatectomy by this incision has been performed over eighty times with satisfaction to the operator, and often with results most gratifying to the patient. Yet in several instances this operation has failed to detect or to remove the prostatic obstruction. It seems therefore that the combined operation by both suprapubic and perineal incisions should be the rule. . . .

The results of the various radical operations have been carefully collected and discussed by Watson. . . . About one hundred and fifty cases are now on record. . . . In about three

fourths of the cases voluntary urination has been restored in patients previously dependent upon the catheter. . . . The mortality of prostatectomy is about 13 per cent. . . .

The salient points in prostatectomy may thus be enumerated: After suprapubic incision further procedures are determined by the size and location of the growths. Pedicled tumors, such as middle lobes, are removed by cautery wire, snare, tonsillotome or scissors. . . . Sessile tumors, such as lateral lobes, can be enucleated by a finger or spoon after the mucous membrane is incised. Protruding parts of the prostate that can be neither excised nor enucleated safely should be treated by sinking a cautery point into them. . . . Usually a suburethral growth is found; a perineal urethrotomy is then made, one forefinger inserted through the incision and the other through the vesical orifice until they meet; obstructions detected are removed according to indications, since the object of the operation is to restore a low-level, unobstructed channel from the bladder to the membranous urethra. The suprapubic wound may often be closed, except for drainage of the prevesical space, and the bladder drained by a large perineal tube extending at least an inch into the vesical cavity . . .

The safest and simplest method of drainage is puncture from the perineum through the prostate, with little or no anesthesia. . . . Between these extremes—the radical operation and perineal puncture—are several measures of intermediate gravity, one of which may be selected according to the vitality and needs of the patient: (1) perineal prostatotomy after Harrison, i.e., urethrotomy, incision of the urethral floor at the vesical orifice, drainage for six to twelve weeks through a large tube. (A distinct middle lobe would naturally be removed when easily accessible); perineal urethrotomy or suprapubic cystotomy for drainage, temporary or permanent.

This article by Belfield, written in 1891, probably was an accurate statement of the attitude of the most advanced surgical urologists in the treatment of prostatic hypertrophy.

In discussing cancer of the prostate, Belfield says, "Cancer of the prostate frequently fails of recognition, partly from neglect to make digital examination per

rectum, partly because cancerous enlargement is not distinguished from the more frequent and familiar hypertrophy of the prostate." Belfield says, "Extirpation of the cancerous prostate has been performed ten times; the patients who survive the operation have all died of recurrence within a few months."

The chapter on cystoscopy was by Dr. Willy Meyer, a urological surgeon who had already published several papers on the cystoscope. Meyer's chapter is a classic and presents in a thorough way the history of the first ten years since the invention of the cystoscope by Nitze.

Meyer describes Brenner's modification for catheterizing ureters. Brenner used Nitze's cystoscope No. 2 in which the operator looked directly straight ahead through a window on the convex surface of the beak. Brenner provided a small channel on the convex side of the shaft through which a catheter or sound could be passed with the object of its introduction into the ureter. Brenner thus succeeded in pushing the catheter into each ureter of a female patient but failed to do the same in the male. Meyer remarked: "The instrument in its present shape is useless, especially in the male." He makes no mention of the successful use of DuRocher's instrument in catheterizing ureters.

In regard to the use of the cystoscope in diseases of the kidney Meyer says, "The diagnostic capabilities of the cystoscope are not limited to diseases of the bladder, but extend to those of the kidney. Not only can we often localize the seat of the trouble—negative vesical evidence giving a positive diagnosis of renal disease—or distinguish whether there are two working kidneys, whether both are affected or only one, and then which of the two. All this is accomplished by observing the character of the jets of urine at the ureteral orifices (transparency, color), timing their frequency and duration, and also by noting the position, shape and injection of the ureteral orifice itself in comparison with that of its fellow." A few cases illustrating these points were

cited, viz.: renal hematuria and renal pyuria.

Meyer discusses at length the great desirability of having a successful ureter catheterizing cystoscope. "All cystoscopists are anxiously awaiting a cystoscope for catheterizing the ureters. . . . Nitze should give it to us." Meyer thus ends his chapter.

In a chapter on "The Cystites," Samuel Alexander, one of the most scientific young urologists in America, presented an excellent discussion. He said, "The study of microbes found in the urinary tract was begun by Pasteur. His discovery in 1859 of the micrococcus ureae, and the investigations subsequently made by Van Tieghem as to the power of this microbe to cause decomposition of urine, attracted widespread attention to the study of the pathogenic microbes in the urinary apparatus. . . . From the discovery of the micrococcus ureae in 1859 to the present time (1891), no less than thirty species of micro-organisms have been found in pathologic urine."

Alexander stressed the danger of introducing bacteria with instruments and insists not only on thorough cleansing of the external genitalia, but says the pendulous and bulbous portions of the urethra should be thoroughly irrigated with Thiersch's solution.

In a chapter on "Injuries of the Bladder," George R. Fowler gave the statistics of Bartels. In 285 cases of gunshot wounds of the bladder, there were about sixty-five fatal results, while in 185 cases of rupture, only seventeen ended in recovery. The statistics of the Civil War, Fowler said, showed a higher mortality in the gunshot wounds, there being ninety-six deaths in 185 cases. In intraperitoneal wounds, Fowler advised immediate laparotomy and suture of the bladder wound. For extraperitoneal wounds of the bladder, he advised exploring the original wound and the insertion of a proper drainage tube. Fowler describes operative methods that have been used in cases of exstrophy. He advised taking flaps from the abdominal wall and making a new urethra by the

method of Thiersch. He says, "The hope of benefit to be derived is solely that an apparatus may be worn to catch the urine with greater facility. There must be of necessity incontinence, as nothing has as yet been devised to take the place of the sphincter vesicae."

The fear of getting into the peritoneum seems to have been very great. In 1888, Helferich proposed resection of the symphysis pubis for the removal of tumors and stones, and Langebuch the same year proposed another route to the bladder which he called "sectio alta subpubica." After the penis was loosened from its attachments the operator went beneath the symphysis to reach the bladder. For tumors of the bladder in the female, incision through the vagina, or colpocystotomy, was favored by some, rather than the suprapubic route. It seems remarkable to us now, when suprapubic cystotomy is considered such a simple operation and so free from danger, that the early operators seemed to fear getting into the peritoneum and went to such extraordinary lengths to reach the bladder by other routes.

Up to 1891, Francis S. Watson was able to report eleven cases of benign tumors which had been treated by operation, in addition to forty-one recently reported by Sir Henry Thompson. In only seven cases had there been no reappearance of symptoms of any kind for three years or more. In three cases the growth had been removed by forceps through a perineal incision. In one female case, the tumor was removed after dilatation of the urethra. In only three cases was suprapubic operation considered necessary. Fifteen patients had died; nineteen were alive less than four years. In the eleven cases of benign growths which Watson collected from various operators, death or recurrence had followed in the large majority of cases. Such was the awful situation in the treatment of benign bladder tumors.

For malignant tumors of the bladder the literature apparently contained only four cases in which resection of the bladder had

been done. Recurrence or death had followed in all cases. The treatment usually employed was drainage, either perineal or suprapubic. A remarkable case is reported by Watson in which Pawlik extirpated the entire bladder and transplanted the ureters into the vagina, the external orifice of which was closed.

Arthur T. Cabot's chapter on "Stone in the Bladder, Prostate, Urethra and Ureters" occupies 130 pages. It is profusely illustrated and is a classic. His discussion of stone-crushing and Bigelow's method of litholapaxy is probably the most important contribution to the subject that has ever been made. Lithotomy is one of the oldest operations in surgical history. Both perineal and suprapubic methods for extracting stones have been employed for centuries. Cabot's description is encyclopedic.

For prostatic calculi, Cabot devised a median perineal operation. In regard to stone in the ureter, Cabot says if it is lodged in the abdominal portion of the ureter it may be reached by Israel's incision. In one case in which an incision had been made into the peritoneal cavity for the purpose of diagnosis where a stone had been found in the pelvic part of the ureter, it was found possible with a hand in the abdomen to lift the stone toward the crest of the ilium where it could be reached by an extraperitoneal incision. For the pelvic portion of the ureter stones were considered beyond operative relief except in the female, in whom the incision was made through the vagina.

"Surgical Diseases of the Kidney" was by Lewis A. Stimson, a celebrated surgeon. For wounds and injuries of the kidney Stimson said: "In some cases nephrectomy either as a primary or secondary operation has been done." For nephrolithiasis, Stimson's advice reads almost like a modern treatise: "The presence of stone having been determined, it should be removed either alone or with the kidney. The choice depends partly on the condition of the kidney, whether it is capable of sufficient functional activity to make its retention

desirable, and if an existing abscess can be satisfactorily drained and partly upon the possibility of making a complete and safe removal of the stone or stones. As a general rule, the kidney should be left if there is reason to believe that any considerable portion of it can do its work. . . . If any stone is left behind, a secondary operation will certainly be required. In cutting for a stone, it is better to make the incision through the parenchyma than through the wall of the pelvis; the bleeding is not severe and the probability of establishment of a urinary fistula is much less." In this statement the treatment of 1890 is at marked variance with that of today. Stimson's advice in tubercuosis is still sound. "In tuberculous disease fairly limited to the kidney, nephrectomy finds a special indication, the removal of a focus of disease in which a general infection may originate. König thinks the operation is clearly called for."

The urologists of the 1880's had already made numerous studies on hydronephrosis. The conclusions reached by Stimson are still acceptable: "This tube may be imperforate, or obstructed by an anomalous branch of the renal artery or folded upon itself from above downward, or obstructed by valvular folds of its mucous membrane or by cysts in its wall, or may have a minute vesical orifice or a very oblique communication with the pelvis." Nephropexy is recognized as an appropriate operation when nephroptosis is the cause of hydronephrosis with symptoms. The technique usually employed was drainage. No reference to corrective procedures at the ureteropelvic juncture are mentioned.

Cysts of the kidney usually were treated by incision, often through the peritoneal cavity, through which the diagnosis was usually made, but Tuffier had just reported the successful extirpation of a cyst and reunion of the kidney parenchyma by suture.

Morris was the most prolific writer on kidney diseases and presented an extensive discussion of the subject of tumors of the kidney.

In regard to the operative treatment, Stimson said the record which comprises more than 100 cases of nephrectomy was not encouraging, and he preferred the extraperitoneal method.

John P. Bryson devotes about forty pages to the subject of urogenital tuberculosis. He says that surgical measures should be held as a last resort, that castration is rarely necessary and that incision, curettage and drainage are the methods of choice. It is rarely advisable to remove a testicle.

Another 100 pages are devoted to minor genito-urinary problems which lack of space forbids discussing.

Such, then, was the situation in urology fifty years ago. Our predecessors had already done splendid experimental and clinical work and shown commendable surgical enterprise. Many of the most difficult operative procedures had already been attempted and some brought to a fair state of perfection. An excellent field had been prepared for the progress which was to be made in the next fifty years.

THE CYSTOSCOPE

We have already referred to the pioneer work of Nitze in the invention and development of the cystoscope and the application of the Edison lamp to his instruments, as well as the instruments of Brenner and Boisseau du Rocher, with which the ureter was catheterized in the female, in a few instances. But all efforts to catheterize the ureter in the male failed. James Brown (1893), by modifying Brenner's instrument so as to employ a curved stilet which facilitated the introduction of the catheter, was the first to catheterize the ureters in the male. A little later, Halsted was the first to carry out nephrectomy as a result of the diagnosis of pyonephrosis, following ureteral catheterization by Brown. Also in 1893, Kelly brought out his cystoscopic endoscope and introduced the principle of distention of the bladder with air by placing the patient in a position

to obtain negative pressure. Casper (1895) devised the first apparently successful catheterizing cystoscope with right-angle vision. In 1897, Albarran designed his elevator which could be operated by an external screw so as to elevate the catheter and direct it into the ureter. After that, various modifications were made; worthy of mention are the photographic cystoscope and various operative cystoscopes of Nitze. In 1900, Reinhold Wappler, of New York, made for William K. Otis the first American cystoscope. About the same time F. Tilden Brown presented the first double catheterizing cystoscope; this was the direct type of cystoscope. Subsequently he introduced an indirect double catheterizing cystoscope of the Wappler type. Bransford Lewis (1903-1904) simultaneously did much pioneer work which led to various types of cystoscopes and cystoscopic apparatus. McCarthy (1923) presented a new type of telescope which looked almost directly forward, which he called the foroblique system. This was a very important addition and made possible the construction of many other instruments by Wappler for various designers, both urologists and specialists in other branches of medicine. As a matter of fact, the instruments used for cystoscopic work by urologists have had tremendous influence on the development of urology and many other fields of medicine. Leo Buerger played a large part in the modification and development of modern cystoscopes. Young, in a paper entitled "A Critique of Modern Cystoscopes," (1927) presented various new features that had wide usage. He and Butterfield presented small instruments for cystoscopy and ureteral catheterization in children. Various instruments for endovesical manipulation have been presented by Ravich, Lowsley, Young, Buerger and McCarthy.

Instruments of the endoscopic type, first introduced by Simon, Pawlik and other European designers and modified by Kelly in America and made practical by him for ureteral catheterization, have led to the

design and manufacture of various instruments, among which may be mentioned those of Braasch, Greenberg, Buerger and McCarthy. Urethroscopy was firmly established before 1890. The Electro-Surgical Instrument Co., under Mr. Maijgren, has been responsible for various types of urethroscopes, cystoscopes and resectoscopes.

THE X-RAY IN UROLOGY

Very soon after Roentgen published the discovery of the penetrating properties of radiations from Crookes' tube, to which he gave the name x-rays, the method was applied in urology. In 1896, Chapius and Chauvel reported the detection of renal calculi by means of the x-ray. In the following year Fenwick described the use of fluoroscopy at the operating table to locate renal calculi. In the same year, Tuffier tried to visualize the urinary tract by opaque metal ureteral catheters. Klose (1904) suggested the use of bismuth to outline the pelvis and ureter, as had already been done in the intestinal tract. Voelcker and von Lichtenberg (1906) reported the use of colloidal silver as an injection of the ureter and pelvis for radiography. To avoid the fatal cases which sometimes occurred with collargol, J. E. Burns (1915) investigated various other chemical compounds and proposed thorium nitrate as a satisfactory agent free from danger. Cameron, who had been working with Burns, introduced potassium and sodium iodide in 1918. In 1916, H. E. Potter presented the Potter-Buckey diaphragm which made possible much more satisfactory radiograms of the urinary tract. W. F. Manges described fluoroscopic study of the pelvis and ureter by pyeloscopy, in 1918. Others advocated serial urograms, and Jarre and Cummings presented "Cinex Camera Studies on the Urinary Tract" (1930) as a means of recording the motor function of the kidney pelvis, ureter and bladder. In 1919, Braasch and Carman advocated the use of the fluoroscope at the operating table to localize renal calculi and prevent leaving any behind. Waters and Young (1920) obtained

radiographs of the seminal vesicles and vasa after the injection of an opaque solution through the ejaculatory ducts. In 1921, Young devised a combined x-ray and cystoscopic table. Also in 1921, came Carelli and Sordella with independent reports on the use of perirenal insufflation of oxygen to outline the kidney and adrenal gland. In 1923, W. C. Quinby proposed making radiographs of the exposed kidney at the operating table for detecting elusive renal calculi. Lipiodol, which has been extensively used in urology, was introduced by Sicard and Forestier in 1922. Rowntree, Osborne, Sutherland and Scholl (1923) showed that after oral and intravenous administration of sodium iodide, roentgenograms of the urinary tract might be obtained. In 1924, Volkmann reported experiments with lithium iodide, bromide and sodium iodide, and advised the latter drug for urograms. During the same year Rosenstein and others used sodium iodide. In 1929, Dos Santos, Lamas and Caldas further developed the work on arteriography and applied it to a study of conditions in the upper urinary tract by injections made directly into the abdominal aorta. Finally, Swick and von Lichtenberg developed uroselectan, with which very satisfactory intravenous urograms were obtained. Since then, other drugs have been presented for urography.

Thus have the x-ray and the cystoscope, in conjunction with phenolsulfonphthalein, furnished the urologist with diagnostic methods superior to any which may be found in any other specialty.

TESTS OF RENAL FUNCTION

The last fifty years marks the development of a method to determine renal function, culminating in the phenolsulfonphthalein test, the most satisfactory for urological cases. Previously patients with diseased, inefficient kidneys were unwittingly subjected to operation with disastrous results. In 1892, Dreser applied the principle of Raoult and Van't Hoff which showed that the osmotic pressure is propor-

tional to certain other properties, including the freezing point. Thus, by freezing point determinations it was possible to determine the solids present in a specimen of urine. This is known as cryoscopy. F. von Korányi (1897–1898), a Hungarian, and Hamburger (1907) also reported the use of this test.

The first dye test used was that of fuchsin, reported by Bouchard (1877). But within the past fifty years a more important contribution was made by Achard, and Castaigne (1897) described the secretion of methylene blue by the kidneys and used it as a renal function test.

Rosaniline (rosaniline trisulfate of sodium) was introduced by Lepine (1898), and indigo carmine by Voelcker and Joseph in 1903. The objection to all of these dyes was their slowness of excretion and, in the case of some, their only partial excretion by the kidney.

A different phenomenon was used in the test with phloridzin, a sugar which Von Mehring had described in 1885 as producing glycosuria without hyperglycemia. It remained for Klemperer (1895) to use it as a function test after observing that the glycosuria failed to appear in the presence of nephritis. In 1903, Casper and Richter published a book on Functional Diagnosis of Kidney Disease with Special Reference to Renal Surgery.

In 1884, Ira Remsen, professor of chemistry at the Johns Hopkins University, described a red dye-stuff, which he gave the name phenolsulfonephthalein. Nothing further was done with this drug until J. J. Abel tested its physiological properties and showed that over 95 per cent of the drug was eliminated through the kidneys with remarkable rapidity. The drug was again put aside as being of no particular value until 1909 when Abel and Rowntree attempted to see whether phenolsulfonephthalein would be excreted differently in a case in which unilateral nephritis had been produced experimentally in a dog. The dog experiments led to erroneous deductions, but by applying the tests to patients in the hospital Rowntree and Geraghty (1910)

showed that phenolsulfonephthalein was a very sensitive and accurate test of renal function.

Shaw (1925) studied the excretion at more frequent intervals and enhanced the value of the test. Young presented a phthaleinometer in 1930 (with Elvers) and, in 1931, a chart to record thirty-minute readings.

Another great advance in studying renal function came from determinations of the urea content of the blood and urine. In 1904, Grehant reported comparative studies of urea in the blood and urine. The method of Folin for the determination of non-protein-nitrogen was reported in 1905. In 1910, Ambard's constant was introduced. It was supposed to represent the ratio of the concentration of urea in the blood to the square root of the urea output of the urine in twenty-four hours. Later experiments by Addis and Drury, and also by Van Slyke have discredited the "constant d'Ambard."

The urea clearance test of Van Slyke was reported in 1929.

The present Mosenthal dilution-concentration test was antedated by the work of Hedinger and Schleyer in 1914.

Of the various tests used during the past fifty years to determine renal function, the two most important are the phenolsulfonephthalein and the urea content of the blood which the method of Hench and Aldrich (1926) has greatly simplified. The phenolsulfonephthalein test detects renal damage secondary to obstruction much earlier than the determination of the non-protein-nitrogen or urea. But the latter tests are very important especially when contrasted with the phenolsulfonephthalein determinations. Indigo carmine is much less accurate but still valuable, particularly in chromocystoscopy where ureter catheterization is difficult.

NEUROGENIC DISORDERS

The mechanism of micturition has been studied intensively during the last twenty-five years. In 1918, Young published his

observations that contraction of the trigone opened the vesical orifice and initiated micturition. Wesson (1920) made an exhaustive study of the development of the trigone and neck of the bladder, and by means of serial sections demonstrated the arrangement of the musculature. The following year Young and Wesson watched the action of the trigone by endoscopy. In 1923, Macht studied the effect of drugs on the trigone and detrusor; he showed that the trigone was innervated by the sympathetic system and that detrusor action was lessened by adrenalin. Langworthy and his co-workers carried out a long series of experiments on animals, publishing a series of articles on the central nervous system's control of micturition. In 1940, Langworthy, Kolb and Lewis published an extensive monograph on the physiology of micturition, emphasizing control of the bladder by reflex arcs throughout the entire nervous system.

Prior to the introduction of efficient chemotherapy in the management of urinary tract infections, many patients with injury to the spinal cord died as the result of ascending urinary tract infection introduced by catheterization. Fully 80 per cent of soldiers with such injuries died. Sir John Thomson-Walker advocated suprapubic cystostomy. Murphy and Kanavel showed that these bladders would finally overflow and not rupture. Orders were therefore issued by the urological staff of the American Expeditionary Force to refrain from any introduction of instruments into the urinary tract. Nothing further was added to the treatment of acute traumatic lesions until Munro and Hahn (1935) recommended tidal drainage of the bladder in the control of infection. The avoidance of overdistention with consequent damage to the vesical musculature is now considered of paramount importance.

Great progress in the diagnosis of neurological lesions affecting the bladder has been made through clinical cystometry. Intravesical pressure had previously been measured, but Schwarz in 1917, and Adler

in 1918, described determinations of pressure under known volumes. By this method they studied the cerebral control of micturition. Impetus was given to the study of neurogenic disorders by Rose (1927), who described the effect of lesions of the spinal cord on vesical activity. He constructed the first clinical recording cystometer. Learmonth (1931) published a series of articles demonstrating the influence upon the bladder of the presacral nerve. He recommended resection of this nerve to insure more efficient emptying of the bladder in certain cases of vesical dysfunction, and in other instances to relieve vesical pain. Quinby, in the same year, showed beneficial results by resecting the presacral nerve in patients with painful bladders caused by interstitial cystitis. Muschat and Johnson, (1932) by means of a simplified mercury manometer, described the types of activity of atonic and hypertonic bladders. Watkins (1934) showed the value of bladder pressure determinations in disturbances of innervation. His description of five cases of spinal cord injury is noteworthy. Dees and Langworthy, in 1935, produced tabetic bladders in cats by bilateral section of the second, third and fourth dorsal sacral roots. They showed that although these cats were incontinent, their bladder function was restored to normal limits by division of the presacral nerve. In the same year, Lewis, Langworthy and Dees, using a water cystometer, described vesical activity in lesions of the motor nerves. Langworthy, Lewis, Dees and Hesser (1936) published a clinical study of the control of the bladder by reflex arcs through the central nervous system. They demonstrated reflex activity of the bladder in normal persons and in patients with known neurological disease, by kymographic records. In 1936, Simons developed a cystometer with attachments for determining the resistance of the musculature of the vesical orifice and external sphincter. Lewis (1939) presented his recording aneroid cystometer which has simplified the making of permanent records. During the same year, Landes brought out

another very sensitive aneroid cystometer. A monograph on neurologic bladder disturbance was published by Frederick C. McLellan in 1939, emphasizing the value of cystometry. Numerous other instruments have been brought out by Lowsley, Landes, Weyrauch and others for the study of intravesical pressures.

ANESTHESIA

Local anesthesia had already been introduced and used on mucous membranes previous to 1890. However, its use was greatly stimulated by a book written by Heinrich Braun in 1905, entitled "Die Lokalanästhesie." An advance was made when Bransford Lewis, about 1900, (1924) advocated an anesthetic tablet to localize the area of anesthesia more sharply.

August Bier was the first to produce spinal anesthesia by the injection of cocaine into the spinal canal in 1899. One year later Tuffier reported many operations on the genito-urinary tract under spinal anesthesia. The next year, 1901, Goodfellow, in San Francisco, used spinal anesthesia with cocaine for perineal prostatectomy. Little progress was made until cocaine was replaced by less toxic drugs. Tropicocaine and stovaine were generally used. The undesirable reactions were greatly decreased with the introduction of procaine (novocaine) in 1904 by Einhorn. In 1910, S. P. Delaup was able to report its use in 585 genito-urinary cases. In 1912, Gray and Parsons studied the variations in blood pressure associated with lumbar puncture and the induction of spinal anesthesia. Smith and Porter (1915) stressed preventing diffusion of the anesthetic solution into the thoracic portion of the spinal canal. In 1927, Rudolf and Graham advocated the use of ephedrin to prevent depression of the blood pressure. In 1928, Keyes recommended spinal anesthesia for all operations on the bladder and said that he had found ephedrine very effective in preventing the fall in blood pressure. During the past ten years many drugs have been used, but pontocain seems most popular at present.

Injection is usually made between the third and fourth lumbar spines; but for operations on the kidney, the injection is usually made between the second and third lumbar vertebrae and more spinal fluid is withdrawn in making the solution. In many urological clinics spinal anesthesia is considered the method of choice, with a few exceptions, notably children.

Paravertebral anesthesia was originated by Sellheim (1905) and first used in urologic surgery by Kappis (1912). Parasacral anesthesia was originated by Heinrich Braun (1914). Caudal block anesthesia was first successfully used in patients by Stoeckel (1909). Cathelin, before 1900, had used epidural injections of salt solution in the treatment of enuresis and later used cocaine, obtaining anesthesia similar to that of intrathecal spinal anesthesia. Transsacral anesthesia was first carried out by Danis (1914). Edwin Davis has in recent years been a consistent advocate of caudal and sacral block for perineal operations.

In 1911, Kretschmer presented the first paper on ethylene anesthesia in genito-urinary surgery.

Intravenous anesthesia, which was first used in 1872 by Oré, (1873), had fallen into disuse until 1899 when Dreser produced general anesthesia by an intravenous injection of hedonal. Krakow produced a narcosis with a combination of hedonal and chloroform given intravenously, in 1908. Burkhardt (1909) used an injection of ether and chloroform. Other compounds which were injected include paraldehyde, trichlorisopropyl alcohol, magnesium sulfate, ethyl alcohol and avertin, but the use of all these was transitory. Sodium amytal was first used intravenously to induce anesthesia by Zerfas (1929). The use of evipal was reported by Kropp and Taub (1932). Lundy published in 1935 the first report on the use of pentothal sodium, the compound now in vogue.

INFECTIONS

Bacteriology. By 1890, most of the bacteria of importance in genito-urinary

infections had been isolated. Among these were the gonococcus, by Neisser (1879), the tubercle bacillus by Koch (1882), *B. pyocyaneus* by Gessard (1883), staphylococci and streptococci by Rosenbach (1884), *Proteus* by Hauser (1885), Colon bacilli by Escherich (1885) with the recognition of their two main types, chemically differentiated by later work into the genera now called *Escherichia* and *Aerobacter*; and Ducrey's bacillus (1889).

Since 1890, bacteriological investigations have been much more concerned with refinements within the different groups of organisms, with a steadily increasing emphasis on their antigenic constitution, as in the grouping of the streptococci; with improvement of methods for the isolation of bacteria; and with a growing knowledge of the great difference that apparently slight variations in antigenic structure may make in resistance to chemotherapy.

Specifically, the following examples are outstanding:

1. The Gonococcus: The great advance has been improvement of culture methods, now of extreme importance in view of the rapidity with which the organisms become microscopically invisible after sulfonamide therapy. This advance depends upon three steps: (1) The use of improved media, *e.g.*, the "chocolate blood agar" of McLeod (1934), and testicular agar of Anne C. Pitts (1940); (2) the incubation of the cultures in 10 per cent carbon dioxide; and (3) the use of the oxidase test for the detection of gonococcus colonies (Gordan and McLeod, 1928).

2. The Streptococci: The outstanding advances have been

- a. Classification accurately on the basis of hemolysis, J. H. Brown (1919).

- b. Classification on basis of antigenic structure, now superseding the former and based on the work of Lancefield (1933).

- c. Recognition that slight changes in such antigenic structure may make a great difference in resistance to chemotherapeutic agents, as in the resistance of Group D

hemolytic streptococci and related forms to sulfanilamide and similar therapy.

3. The Colon Group: Recognition of the necessity for accurate identification of these organisms in genito-urinary infection (Hill, Seidman, Stadnichenko and Ellis, 1929) and of the differences of resistance of these organisms to chemical attack (Colston and Hill, 1932) has become increasingly important.

4. *Proteus*: The significance of the ureolytic action of this organism, especially in relation to encrusted cystitides (Hager and Magath, 1925) and to recurrent lithiasis is now fully recognized (Smith, G. G., 1939).

At present interest in the enzyme activities of bacteria, such as their ability to split urea (Hill and White, in press) and the action of chemicals upon such enzymes are the vital problems upon which research in genito-urinary bacteriology is centered.

In regard to the more general problem of genito-urinary infection, much remains to be learned. We have as yet few methods for studying the differences of tissue responses and of the resistance of bacteria in the tissues. We have little knowledge of the exact mechanism of chemotherapy in the body. The complexity of these subjects commands correlated researches in many different fields.

Urinary Antiseptics. For many years it has been known that certain drugs were eliminated largely by the urinary tract. *Uva ursi*, turpentine, copaiba and other similar drugs have been employed for generations, almost to the exclusion of other drugs, in the treatment of gonorrhea and other urinary infections. In 1894, Nicolaier brought out methenamine, or Urotropin. He asserted that when given by mouth it was eliminated by the kidneys and was often effective in combating urinary infections. Five years later he showed its good effect was due to the liberation of formaldehyde. Burnam (1912) found that the liberation of formaldehyde by different individuals varied greatly. Hinman (1913) showed that unless given in huge quantities

formaldehyde had very indefinite action against bacteria and was more effective in the bladder than in the kidney. Other experimental work on these drugs was published by Shohl and Deming (1920), Thomas and Wang (1929), Vermooten and Berry (1933) and others.

In 1914, Abelin found that after intravenous injections of neosalvarsan formaldehyde appeared in the urine. This was not true with salvarsan. Porges (1916) reported a case of tabes with infected urine which cleared up on neosalvarsan injections. Gross (1917) confirmed the efficacy of neosalvarsan in gonorrheal cystitis, but reported no effect on *B. coli* infections. During the World War Levy-Bing found that in cases of syphilis complicated by gonorrheal epididymitis, intravenous injections of neosalvarsan resulted in rapid improvement of the epididymal infection. After returning from France, Young began to use intravenous injections of neoarsphenamine in various types of coccic infection of the urinary tract. Of thirty-nine upper tract infections, ten were sterilized, thirteen improved and sixteen were failures. After chemical study White asserted that it was difficult to explain the action of the drug, as not enough formaldehyde was eliminated to make antiseptic urine. The work of Ramon, who in 1923 described a detoxifying action of formaldehyde, suggests another possible mode of action of neoarsphenamine. In 1918, Davis advocated acriflavine for gonorrhea. He also claimed results intravenously.

In 1924, Young and Hill presented cases of urinary infection which had been treated the previous year by the intravenous injection of 1 per cent mercurochrome. The first case was one of bilateral pyelonephritis in which following ureteral catheterization the patient had septicemia. When desperately ill he was given 34 cc. of a 1 per cent solution of mercurochrome intravenously by Dr. J. A. C. Colston. This was followed by a rapid disappearance of the fever, and sterilization of the blood and

also the urine, both of which were heavily infected with *B. coli*. In the same paper a case of urinary infection treated by gentian violet was reported. Hill and Colston (1923) demonstrated bacteriostatic action of urine after intravenous injections of mercurochrome into rabbits. Young and Birkhaug (1924) reported a case of scarlet fever complicated by streptococcus infection of the urinary tract. This desperate case was quickly cured by an intravenous injection of mercurochrome. In 1925, Young, Scott and Hill presented an exhaustive collection of cases treated by intravenous mercurochrome. These reports came from numerous authors and demonstrated the great value of mercurochrome when introduced intravenously in many different types of infections, local and general. This report included twenty-three cases of pyelonephritis, four cases of cystitis and prostatitis, thirty-seven cases of gonococcic infection, among which were twelve cases of gonorrheal arthritis, many of which were shown to be amazingly improved by intravenous injections of 1 per cent of mercurochrome. The use of the drug was shown to be comparatively free from serious danger, although troublesome complications, especially nausea, vomiting, diarrhea, stomatitis and high fever occasionally occurred. Confirmation of the value of intravenous mercurochrome was obtained from many writers, among whom may be mentioned several from the Mayo Clinic, particularly those papers on the use of the method in pyelonephritis by Braasch (1926) and recent papers by Emmett and by Livermore.

Although an impartial review of the large number of reports on the intravenous administration of mercurochrome justified the conclusion that excellent results were sometimes obtained in general and local infections, still the fact that it had to be given intravenously and was frequently followed by uncomfortable reactions and could not be successfully employed by mouth, markedly interfered with its general adoption. When sulfanilamide, a drug that

could be given in larger quantities by mouth, appeared, the stage was set for its adoption by the medical profession.

Sulfanilamide was made by Gelmo in 1908. The complex history of these compounds is clearly stated by Justina Hill in her book, "Germs and the Man." Long and Bliss were the first to present experiments with sulfanilamide in this country. Very promptly, studies on the effect of the drug in genito-urinary infections were reported by Helmholtz (1937). Vest, Young, Herrold and others reported cases of genito-urinary infections in human beings. In the spring of 1937, Reuter of Washington, and Dees and Colston of Baltimore simultaneously began treating cases of gonorrhea with sulfanilamide. Their reports of remarkable results in the disappearance of the urethral discharge and the gonococcal infection startled the urological profession, and the use of the drug in gonorrhea soon became widespread. In the past three years innumerable articles have appeared that attest to the great value of this new form of therapy. Culp, in a critical analysis of cases of gonorrheal arthritis treated by intravenous mercurochrome and sulfanilamide by mouth, showed practically equally great efficacy of the two methods. Mercurochrome was a little more rapid in its effects.

With the introduction of sulfapyridine, better results were obtained in the treatment of staphylococcic infections. It was soon found that this drug was also effective in many cases of gonorrhea (Michon, 1939; Herrold, 1939) and of bacillary urinary infections. Sulfathiazole, possessing the most powerful direct antibacterial action of any of these three drugs has, within a year, established itself as a compound of great value in the treatment of urinary infections. Helmholtz (1940) reported that sulfathiazole and sulfamethylthiazole kill both *Streptococcus fecalis* and *Staphylococcus aureus* in lower concentration in the urine than the Gram-negative bacilli. The failure of these drugs to protect against or sterilize urinary infections due to Group D streptococci, especially gamma Strepto-

coccus fecalis and *Pseudomonas pyocyanea* remains their great weakness as urinary disinfectants. The possibility of surgical prophylaxis against wound infection with sulfathiazole has recently been shown (Young, Hill and Semans). The action of sulfanilyl guanidine either directly or indirectly in urinary infections remains to be shown. Other modifications of these drugs have been put on the market and are being tested in laboratories and clinics. It is evident that in the near future more specific and more efficient drugs will be on hand to combat the various types of genito-urinary infections, but already tremendous strides have been made, and in no other field of medicine has the use of chemotherapy proved more remarkable than in urology.

In 1917, Shohl and Janney reported that *B. coli* were inhibited from growing in urine with a pH between 4.6 and 5.0 and between 9.2 and 9.6. This demonstration of the inhibitive effect of marked acidity and also marked alkalinity has had a pronounced effect on subsequent investigations of urinary antiseptics. Clark (1931) observed that urine containing ketone bodies was bacteriostatic. He and Helmholtz at the same time reported a series of cases of adults and children in which they had successfully treated bacillary infections by placing the patients on a ketogenic diet. Fuller (1933) showed that beta-hydroxybutyric acid was the active bactericidal substance in the urine of patients on a ketogenic diet. Crance and Maloney (1935) announced that the oral administration of nitrohydrochloric acid resulted in the reduction of the pH of urine to 5.3 or less, and in a shorter time than with the ketogenic diet. He reported a series of favorable cases. Rosenheim (1935) announced that mandelic acid is closely allied to beta-hydroxybutyric acid and that when given by mouth it is excreted unchanged in the urine and possesses the same bactericidal properties as beta-hydroxybutyric acid without its toxicity. A month later, Cook and Braasch reported local instillations into the bladder of solutions of beta-hydroxy-

butyric acid which served in some cases to sterilize bacillary infection of the bladder. Yeaw (1940) has re-studied the effect of acidity on bacteria in the urine and has shown that while, clinically, bactericidal levels could be reached only for the streptococci, a bacteriostatic level could be reached which would inhibit the growth of all organisms except *B. coli*.

UROLITHIASIS

Since time immemorial it has been known that urinary calculi occur in certain geographic districts with far greater frequency than in others. In India, stone is very common among the natives who live in the upland districts away from the seashore. The assumption was drawn many years ago that the difference in diet between these two classes of natives played an important role in the development of calculi. But it was not until recently that the subject has been studied scientifically and real progress made.

Etiology. Bartlett (1895) asserted that infection played an important part in the development of nephrolithiasis and classified the routes of infection as (1) descending infection from the circulation in septicemic conditions; (2) ascending infection from a focus lower in the urinary tract; and (3) transmission from neighboring organs by contiguity. Guiteras (1906) stated that calculi are precipitated from urine as a result of decomposition due to some local infection or inflammation. Kretschmer (1916) studied cystine calculus and discovered the presence of cystine crystals in the urine. Osborne, Mendel and Ferry (1917) observed that calculi, both renal and vesical, could be produced in white rats which were maintained on a diet deficient in vitamin A.

Linwood Keyser has played an important part in the explanation of the etiology of urinary calculi in a series of papers. His first paper (1922) was published in conjunction with William F. Braasch. In a clinical study they concluded that some local mechanism was at work in the renal pelvis

or bladder which caused the formation of calculus. They also considered the possibility of a specific stone-forming infection as an etiologic agent. They felt that excessive excretion of crystalloid material may reach such a degree that the protective colloids in the urine could not handle the extra burden.

Rosenow and Meisser (1923) reported experiments in which a focus of infection present in the teeth of animals, produced by the insertion of streptococci, obtained from urine of patients with urinary calculi, caused similar calculi to appear in the kidneys of the animals.

The foregoing observations led to a great deal of work on the development of calculi and their prevention by the removal of points of obstruction, provision of free drainage, correction of diet, and the elimination of focal and local infections. Prominent among these was a paper by Guy Hunner (1924) who emphasized the importance of ureteral stricture in the formation of renal calculi.

In 1933, Charles C. Higgins reported the results obtained in white rats which had been kept on a diet deficient in vitamin A for 200 days. It was discovered that in 88 per cent of the animals vesical calculi had developed; at the end of 250 days, renal calculi had developed in 41 per cent. H. C. Hou (1936) and others observed that by the addition of vitamin D to the diet which was poor in vitamin A, the percentage of animals in which calculi developed was increased.

In January, 1934, Albright, Baird, Cope and Bloomberg demonstrated the types of renal complication which may be associated with hyperparathyroidism. They reviewed eighty-three cases of hyperparathyroidism. In forty-three, there was a renal complication; twenty-three showed precipitation in the renal pelvis, with pyelonephritis; in nineteen, there was precipitation in the renal tubules with resulting renal sclerosis; and in one, there were calcium deposits in the form of fine granules in the kidney as well as in many other organs.

In April, 1934, Albright, Aub and Bauer published the results of a comprehensive study of seventeen cases at the Massachusetts General Hospital in which a parathyroid tumor had been removed. In one case a plain roentgenogram of the abdomen revealed in the region of each kidney stellate groups of punctate shadows outlining the renal pyramids, leading to the proper diagnosis.

In May, 1934, Albright and Bloomberg cited eleven cases from a series of twenty-three proven cases of hyperparathyroidism at the Massachusetts General Hospital where the presence of renal stones was the only clue which led to the diagnosis of the underlying disease. They stated that many finely granular casts containing calcium were often found in the urinary sediment. These casts could be made to change into hyaline casts by acidification of the urine. The authors considered them to be microscopic calculi from the renal tubules.

In September, 1934, Barney and Mintz reviewed a group of eighteen cases of hyperparathyroidism which had been proved by operation. In eleven (61.1 per cent) urinary calculi were present. They concluded that parathyroid disease was present in 10.5 per cent of their total series of 104 cases of urinary calculus.

Griffin, Osterberg and Braasch (1938) reported that in a study of a large number of cases of urinary lithiasis they had found hyperparathyroidism to be an etiologic factor in less than 0.2 per cent. Higgins concurred in the opinion that parathyroid disease was a rare concomitant. Nevertheless, it is accepted now that *x-ray* studies of the bones and determination of the amount of calcium in the urine should be made when there is an elevation of the serum calcium and a lowering of the serum phosphates.

Flocks (1939) reported his results of a study of thirty-five patients with calcium urolithiasis. In 66 per cent an abnormally high calcium excretion was found in an analysis of the urine. In the great majority of these, there was no evidence of bone

disease, hyperparathyroidism, change in the blood calcium or phosphorus or other demonstrable abnormality of calcium metabolism. In cases of this sort he recommended prophylactic measures to prevent recurrence, consisting of a low calcium intake, acidification of the urine, and vitamin A without admixture of vitamin D.

In 1912 and again in 1913, Caulk reported cases of primary necrosis of the papilla with deposition of calcium phosphate. The possible relation between this and renal calculus was not mentioned. In 1936, Alexander Randall expressed his opinion that the development of a primary stone in the kidney follows a lesion in the papilla. He found in kidneys removed at autopsy subepithelial and extratubular deposits of calcium in the papilla. He concluded that such a calcium plaque subsequently loses its epithelial covering. Urinary salts are then deposited from the circumambient urine. He stressed the fact that this process occurs in the absence of urinary tract infection and obstruction. A full exposition of this subject has been made in his recent paper (1940).

Diagnosis. Before 1895, Howard A. Kelly introduced bougies and catheters coated with wax bulbs and thus diagnosed by scratch marks the presence of calculi in the upper urinary passages. By the use of wax bulbs placed at intervals along the course of the bougie, Kelly was able to determine with fair accuracy the exact location of the calculus in the ureter. In 1895, Roentgen announced the discovery of his *x-ray*; the following year McIntyre of England demonstrated positive films for stones in five cases of renal calculi in which the stones were subsequently removed at operation. In 1899, Abbe collected from the literature over twenty cases in which a diagnosis of stones had been made by *x-rays*. Kelly and others further aided in the diagnosis by introducing shadow-graphic catheters. The successful cystoscopic catheterization of the male and female ureter by Brown in 1893 and by Kelly in the same year added much in-

formation to the condition of the kidneys in cases of nephrolithiasis.

The introduction of pyelography by Voelcker and von Lichtenberg (1906) added another important diagnostic measure.

When the phthalein test was introduced by Rowntree and Geraghty (1910) information of much value became available. The capstone was added when von Lichtenberg (1929) announced the perfection of intravenous urography by means of uroselectan.

In the meantime, the x-ray, which at first required exposures of over thirty minutes to depict calculi, became more and more rapid and efficient, and with the development of stereoradiography combined with other scientific measures, above outlined, furnished precise information of great value in the diagnosis and treatment of urinary calculi. Braasch's classic book on pyelography (1915) was of inestimable value in systematizing the knowledge of the subject.

Surgical Treatment of Renal Calculus. By 1890, the surgical treatment of renal calculus had already made great advances. The oblique muscle-cutting extraperitoneal technic was usually employed, Israel extending the incision downward to expose more and more of the ureter. For ten years stones had been removed through the kidney or pelvis, and many papers describing different methods had appeared. Since then the literature on this subject has been vast. Many of the papers, while presenting much interesting information and statistical data have very little that is entirely new on the subject. In this vast bibliography it is impossible to do justice to even the most important contributions. It was soon realized that operations through the renal cortex were often accompanied by severe hemorrhage, and the trend to pyelotomy had already begun.

In 1898, Robson presented a paper on the method of exposing and operating upon the kidney without division of the muscles, vessels or nerves. Kelly also wrote on the same subject. In 1912, W. J. Mayo also

presented a special incision for lumbar exposure of the kidney.

In 1901, Broedel, after interesting work on animals and in autopsies, described a zone in the kidney which was relatively free from blood vessels. He showed that the kidney was supplied by an anterior and a posterior group of arteries which did not anastomose. This zone lies immediately beneath a line which was parallel and slightly posterior to the lateral convex border of the kidney. In order to bisect the kidney along Broedel's line, Cullen and Derge (1909) introduced a silver wire with a long straight or curved blunt needle. The wire was drawn back and forth along Broedel's line, which had been marked out with a scalpel on the outer border of the kidney. In this way the kidney was bisected along the supposedly rather avascular zone. Many observers, however, did not find that the operation had been rendered much less bloody by this technic; in recent years operators usually have preferred to go more or less directly down upon the known location of the calculi. Kelly advised that when the incision was made to reach a calculus, it should be, if possible, perpendicular to the hilus and thereby avoid dividing transversely the blood vessels as they travel outward from hilum to cortex.

When extensive incisions were required in the kidney cortex, hemorrhage presented a great problem. It was soon found that the vessels of the pedicle could be clamped for only a short period without danger of seriously impairing the tissues of the renal cortex. In the closure of cortical incisions, mattress sutures usually bolstered by masses of fat (Mayo) or muscle tissue were generally employed by various operators. The great difficulty with the removal of stones by nephrotomy was the uncertainty in removing every last stone or fragment; this still is one of the great problems of renal surgery. The removal of stones through incisions in the pelvis or adjacent ureter soon was recognized as the better method of approach by almost all operators, but there was a divergence of opinion

as to whether the pelvic wounds should always be sutured or often left open. In 1913, Lower discussed conservative methods of operating upon the patient with stone in the kidney.

Fenwick (1897) suggested and used the fluoroscope at the operating table to rule out urolithiasis and to establish the diagnosis in doubtful cases.

In 1917, J. Edward Burns presented a new method for locating small calculi deep in the kidney and at operation. His method was based on the use of stereoscopic x-ray films and accurately determining the point beneath which the stone lay and finding it by needling. Braasch and Carman (1919) made use of the fluoroscope at the operating table to localize renal calculi and particularly to determine whether all stones had been removed. Quinby (1925) presented a paper on the localization of renal calculi by x-ray films made during operation.

Lowsley and Bishop (1933), acting on the suggestion of William P. Didusch, introduced the use of broad strips of ribbon catgut to close extensive nephrotomy wounds. Ribbon gut has been used by Lowsley and others in many other operations.

An important paper was that of George Prather (1934) who presented a new operative technic for widely opening a kidney to facilitate the complete removal of a stag-horn calculus. It consists of a v-shaped incision, the apex being at the pelvis and the branches extending out toward each pole. Through this incision Prather was able to remove large staghorn calculi and be sure that no fragments remained. Successful closure with sutures was carried out.

Counseller and Hoerner (1936) advised the introduction of a drainage tube through the cortex into the pelvis to aid in the rehabilitation of an extensively damaged kidney after removal of stones. On the other hand, Keyes recommended pyelotomy drainage for nephrotomy wounds in 1917.

One of the greatest problems in the

surgery of renal calculi arises when both kidneys are the seat of stones. An early paper on the subject was that of Nicholich (1910). Braasch, Higgins, and Hinman have also contributed important articles on the subject. Hryntschak (1933) reported fifteen cases of bilateral stone, seven of which were operated upon in one stage without a postoperative death. Each case presents a problem that requires individual consideration.

Another serious question is, when is one justified in doing a nephrectomy for renal calculus? Numerous authors agree that many kidneys are so greatly injured that nephrectomy is the safest and surest method of curing the condition, but the danger of the development of stones in the opposite kidney has made various surgeons hesitate before carrying out nephrectomy.

With the advent of sulfanilamide and its derivatives, and the ability to sterilize the urinary tract after removal of calculi, the chance of preventing recurrence and the eventual development of a calculus on the opposite side is brighter. When renal calculi were present on both sides and recur after operation, one is often confronted with the problem of what to do to save the patient's life. In 1908, Francis Watson reported that he had established a permanent renal fistula in a case from which a calculus could not be removed. The procedure, which Watson called nephrotresis, was effective for the many years that the patient lived. Watson also described transplantation of the ureter to the loin for renal drainage—dermatoureterosis, he called it. Subsequently, he said that thirteen cases had been reported. Bovée mentions five cases in which the ureter was anastomosed with the urethra.

Cystoscopic Treatment of Ureteral Calculus. In 1901, Young detected a stone projecting from the left ureter and extracted it by means of a bougie passed through the cystoscope (published in 1902). Kelly and his associates popularized the dilatation of the ureters by large catheters and bougies to facilitate the passage of

calculi down the ureter. A little later Hall reported a case in which he had removed a calculus caught in the lower end of the ureter in a female by means of Kelly's cystoscope. Cystoscopic dilatation of the lower end of the ureter to make room for the escape of a calculus was successfully carried out by Kolisher, Casper and Kreissl.

"In 1904, Bransford Lewis amplified and modified endoureteral instruments of Kohlman, Oberlander and others, and presented his operative cystoscope for use in the bladder and lower ureter. This was the first formulated cystoscopic attack upon ureteral calculi and stricture and paved the way to cystoscopic ureteral surgery as it exists today." (Ernest G. Mark.)

Among those noted for extraction of many and large calculi by endoureteral means, A. J. Crowell (1921) deserves special mention. In 1926, Councill presented his stone extractor, a wire basket which could be expanded so as to entrap a calculus as it was drawn down the ureter. With this instrument Councill has been very successful in removing a great series of calculi, now almost 500. A somewhat similar instrument was invented by Franklin P. Johnson (1935). Other technics for the extraction of calculi, such as introduction of several small bougies or catheters, have been introduced from time to time. Among these writers may be mentioned McKay, and Alyea. Various drugs such as pantopon, novocain and avertin, the latter by Jarman and Scott (1937), have been introduced into the ureter to cause dilatation and facilitate the passage of calculi.

Surgical Treatment of Ureteral Calculus. By 1890, the extraperitoneal removal of ureteral calculi had already been carried out in several cases, either through an incision in which the kidney was exposed or through one lower down in which only the ureter was isolated. In some cases, in women, calculi were removed through an incision more or less parallel to the spines of the vertebrae without cutting the abdominal muscles. In 1935, Frederic E. B.

Foley approached the upper ureter by an incision parallel to the last rib through which the ureter could be reached without cutting any muscles. At the apex of Petit's triangle the muscles were retracted, exposing the lumbodorsal fascia which Foley incised in the direction of its fibers and thus gained access to the ureter extraperitoneally.

Calculi in Pelvic Portion of Ureter. In 1898, Fenger in a classical work on the ureter said:

There is no difficulty in gaining access to the upper three-fourths of the ureter by the oblique lumbar incision. It is different with the lower fourth of the ureter which is located deep down in the pelvis and is even held by Le Dentu to be inaccessible. But as Cabot has pointed out, this portion is also accessible without opening into the peritoneum by means of the sacral operation of Kraske.

But no one had used the Kraske incision, and in December, 1899, Henry Morris, after an exhaustive study of the literature, said that no case had been reported of ureterolithotomy for stone impacted in the lower end of the ureter in the male.

Helferich (1894) published a case in which after removing a vesical calculus suprapubically he discovered another stone projecting from the mouth of the ureter. The orifice was dilated and the calculus extracted. Pitts (1898) described one case, Bishop (1899) two cases and Newman (1900) also published two cases. In 1898, Fenwick removed a calculus from the lower end of the ureter through a transverse perineal incision in a male aged eighteen. He reached this stone retroversically and extracted it through a longitudinal incision. It was about the size of a small peach stone. In 1887, Ceci found, on rectal examination, a large, hard mass in the region of the left ureter and after dilating the anus a bistoury was inserted and seven stones removed from the left ureter. The patient died thirty-six hours later.

In 1901, Morris reported two cases in females in which, through an incision five

inches long parallel to the sacral spines and two inches distant from the middle line, he had removed a stone from the ureter just above the bladder with the assistance of a sound in the bladder and a finger in the vagina. Both patients recovered. The upper extraperitoneal route was used by Twynam in 1890. The patient was a boy of eight years. Exploratory laparotomy was performed and a small ureteral stone found by the hand in the abdomen. It was lodged near the vesical end of the ureter. At a later date, through an oblique abdominal incision, the ureter was exposed extraperitoneally, the ureter brought up and incised and the stone removed. The wound was closed with silk sutures. The patient recovered. After this first case stones were successfully removed from the pelvic portion of the ureter by Morrison and Israel (in three cases) in Europe.

In 1902, Young reported the first cases in which stones had been removed from the lower end of the ureter in the United States, one by himself and one by Finney. Both patients recovered.

These early operations upon the lower end of the ureter were through a low oblique muscle-cutting incision. Later, through a similar incision, the gridiron principle was extraperitoneally employed, and the pelvic ureter reached without division of the abdominal muscles.

In 1910, Gibson reported that he had been using a long curved incision in the lower quadrant. The lower end of the incision was carried horizontally just above the pubis to the midline. The incision then extended laterally a little above Poupart's ligament to about the midpoint and then ascended vertically to end just medial to and a little above the anterior superior spine. The aponeurosis of the external oblique was incised in the direction of this incision, and the only muscle which was divided was the internal oblique. The transversus abdominis was split in the direction of its fibers. A vertical incision along the lateral border of the rectus sheath enabled the rectus muscle to be re-

tracted medially and gave a wide exposure of the pelvis.

Removal of Ureteral Calculi through the Vagina. "Although Emmett (1884) was the first to describe the vaginal route for removal of ureteral calculi, there is apparently no record of the operation having been successfully performed until 1890 when Kelly published his first case. From this time until Lower reported 6 cases in 1925, the operation was only occasionally mentioned in the literature." (Louis M. Orr.)

E. Clay Shaw (1936) described four cases in which calculi had been removed from the lower end of the ureter per vaginam. In discussion Orr said that the total number of cases in which this method had been used was somewhere around fifty.

Removal of ureteral calculi by division of the orifice through the bladder had been reported by various operators. Some used scissors; others (Furniss) fulguration; and still others, division with a knife electrically heated.

Vesical Calculi. Since time immemorial stones have been removed from the bladder either through a suprapubic or a perineal incision. Efforts to remove calculi by instruments through the urethra has almost as long a history. Before 1890, Bigelow had produced his remarkable lithotrite and method of removing calculi by litholapaxy. Since then very little has been added to the subject except modification of the design of the instruments employed. Chismore (1884) presented his evacuating lithotrite which had the advantage that stones could be drawn in between the blades by suction, crushed and evacuated without removing the instrument. Young (1910) designed an evacuating lithotrite of much larger capacity than Chismore's and was provided with a long cystoscope. Other cystoscopic evacuating lithotrites have also been introduced, among which may be mentioned Ravich, Lowsley, etc. Kretschmer modified Young's cystoscopic rongeur by making the blades so strong that calculi

could be crushed between them. One of the most recent advocates of litholapaxy is Gershom J. Thompson.

Much has been written about the complications of vesical calculus: enlarged prostate, contraction of the vesical orifice, diverticula, etc., but we shall not attempt to analyze the literature.

Prostatic Calculi. Guyon (1899) was one of the first to present an extensive study of the pathology, diagnosis and treatment of calculi in the prostate. B. A. Thomas and J. T. Roberts (1927) in a masterly article, brought the progress of urology as applied to prostatic calculus up to date. They showed that prostatic calculi are not rare, that about 65 per cent were symptomless, that an indurated mass might be mistaken for cancer, but the diagnosis could be made by the x-ray in almost all cases, and that surgical intervention by the perineal route was the treatment of choice except in those cases in which the calculus communicates with the urethra, when it may be removed urethroscopically. Young (1934) presented an exhaustive study of 100 cases in a paper in which he agreed with Thomas.

Recently Gershom J. Thompson (1940) asserted that calculi might be removed with great ease by endourethral methods generally associated with prostatic resection. J. Swift Joly's "Stone and Calculous Disease of the Urinary Organs" contains much interesting data.

Preventive Treatment of Urolithiasis. Charles C. Higgins (1939) thus summarizes the therapy in urolithiasis:

1. High vitamin A, acid-ash or alkaline-ash diet to prevent the formation of calculi in patients with orthopedic conditions and in those who have passed calculi at frequent intervals, but in whom no stones are present in the kidney. The same diet may, in rare cases, be of value in dissolving calculi already present.

2. Preoperative investigation to ascertain the etiologic factors associated with the formation of the calculus.

3. Postoperative routine to prevent recurrent calculi by a high vitamin A, acid-ash or alkaline-ash diet.

4. Bacteriologic study of the organisms present and appropriate treatment.

TUMORS

Tumor of the Kidney. The most common is that described by Grawitz (1883) and supposed to be a development from adrenal rests in the kidney. Lubarsch (1894) gave the name hypernephroma. There has been much discussion as to the etiology and cellular pathology of these tumors. In 1899, Wilms described a new renal tumor which he declared to be an adenomyosarcoma. Since then, this tumor has been known as Wilms' tumor. His findings were confirmed in 1901 by Israel in his great monograph, "Chirurgische Klinik der Nierenkrankheiten." One of the most important contributions was that of Albarán and Imbert when they published their "Tumeurs du Rein" (1903).

Primary neoplasms of the renal pelvis are much more rare than cortical tumors. Meltzer (1926) was able to collect only 181 cases in the literature. Hunt (1927) in a report of 318 nephrectomies for renal tumor found only twenty-three primary epitheliomas of the renal pelvis.

Hyman (1928) showed in a collective review of ninety-nine cases that only 15 per cent of renal tumors of the kidney were cured by nephrectomy.

In 1926, Bothe found that Wilms tumors were radiosensitive. Waters, Lewis, and Frontz (1934) published a series of six cases of renal tumor in adults which had been subjected to preoperative radiation. They concluded that all large cortical renal tumors should be subjected to irradiation before operation because the marked reduction in size caused by this treatment, made operation much easier and possibly lessened the likelihood of metastases. Lawrence Wharton (1935) came to the same conclusion. All agreed that nephrectomy was the only hope of an ultimate cure. There is still much discussion as to

whether the extra- or intra-peritoneal approach is preferable in kidney tumors.

A gradually increasing number of cases have been reported in which there has been a recurrence of the epithelioma in the terminal portion of the ureter which was not removed by nephroureterectomy. The importance of complete nephroureterectomy at one séance is stressed by V. C. Hunt in a report of fifteen cases of papillary epithelioma of the renal pelvis, in 1927. In some of the cases a considerable portion of the bladder wall involved in the tumor at the lower end of the ureter was removed. After nephroureterectomy Colston destroyed the epithelioma of the lower end of the ureter by fulguration and later removed a bladder diverticulum in which a papilloma had become implanted.

Tumor of the Bladder. With the development of cystoscopy, the diagnosis and and operative treatment in tumors of the bladder made rapid progress. In 1896, Nitze introduced his operating cystoscope, an instrument with which he could snare the tumor, burn through the pedicle and cauterize bleeding vessels. He later described one hundred and fifty cases treated with his instruments and reported only twenty recurrences and one death. In 1905, Weinrich reported one hundred and one cases treated by Nitze's method with 71 per cent recurrences. Luys (1903) destroyed tumors electrically through his open air endoscope. D'Arsonval (1893) brought out the bipolar high frequency current, and Oudin the monopolar method. These were employed variously in medical practice, but apparently Edwin Beer (1910) was the first to use a monopolar current in the destruction of bladder tumors with a cystoscope, almost simultaneously with E. L. Keyes, Jr., who used the bipolar current. Both of these pioneers were greatly assisted by Reinhold Wappler who was responsible for many cystoscopic improvements.

In 1915, Geraghty, from cystoscopic observation, described four types of bladder tumor: benign papillomas; malignant papillomas, papillary carcinoma and in-

filtrating carcinoma. In 1922, Broders presented a microscopic classification of bladder tumors from biopsy specimens.

Endovesical destruction of tumors of the bladder by the high frequency current through a cystoscope was utilized all over the world. It soon became evident that many malignant papillomas could not be cured by this treatment, and that other papillomas, described microscopically as benign, eventually showed evidence of malignancy at the base and were not curable by the high frequency current. In 1911, Paschke described a cystoscopic radium applicator, but he reported no cases. It was at this point that Pasteau and Degrais presented at the International Medical Congress in London (1913) a paper on the use of radium introduced into the bladder with an ordinary rubber catheter. They reported four cases of carcinoma of the bladder and prostate with beneficial results. Young (1917) introduced a cystoscopic radium applicator, the beak of which carried 100 mg. radium. The outer part of the instrument was provided with a ball that could be grasped by a clamp attached to the table and thus hold the radium in the position in which it had been placed under cystoscopic direction. He reported the use of this instrument in early malignant papillomas and also in the treatment of bases of other papillomas. Young later introduced additional instruments which could be used with the same straight cystoscope for making applications of radium by different mechanical devices to various parts of the bladder.

In subsequent publications the remarkable results obtained by a combination of fulguration and radium application were reported from the Brady Urological Institute (Scott, McKay, Colston, Geraghty and Denny).

Very extensive resections of the bladder have been reported by various operators. Hemi-section was strongly advocated for tumors involving one side of the base (Squier). A few cases were cured by these radical procedures, but recurrences were

many and the immediate mortality high. For such cases the implantation of radium through a suprapubic wound was advocated by various operators, usually after the intravesically projecting portion of the tumor had been removed by the cautery. Barringer (1915) employed radium emanation seeds which were introduced cystoscopically or suprapubically into such tumors. He and Dean have reported great series of cases exclusively treated by radium especially with gold seeds. Despite these endovesical methods it is generally accepted now that malignant, and especially infiltrating tumors of the vertex, anterior and lateral walls of the bladder and portions of the posterior wall should be attacked by radical resection of the bladder wall around the tumor. In many cases it may be necessary to go into the abdomen and excise a considerable portion of the peritoneum covering the bladder, along with the neoplasm. Young (1930) introduced a transvesical method of removing malignant tumors of the posterior wall of the bladder along with both the entire bladder wall and the peritoneum covering it. He showed that this method provided a simple way of attacking tumors of the posterior wall of the bladder without first going into the peritoneal cavity.

Deep x-ray therapy has long been used in the treatment of malignant tumors of the bladder and prostate. The general consensus of opinion is that it has been very ineffective. D. K. Rose (1935) advocated the application of deep x-ray therapy to bladder tumors which are exposed directly by wide opening of the bladder, the walls of which are held apart by special retracting instruments. By this plan the intervention of the abdominal wall and the anterior wall of the bladder are removed and the x-rays are permitted to operate directly upon the interior of the bladder containing the tumor. The results obtained by this method are, so far, not convincing.

Fletcher Colby (1939) reported a small group of malignant tumors of the bladder treated by supervoltage x-radiation with a

recently devised million volt generator operated by Richard Dresser. Colby stated that "although the series is entirely inadequate to evaluate fairly this form of treatment, certain tumors appear profoundly affected, with considerable regression. Those portions of the tumor which project into the bladder cavity seem to be affected considerably more than those which have extended through the bladder wall." The help and co-operation of Dr. Richard Dresser was acknowledged.

In another paper (1940) Colby reported on twenty-four cases, among which there were seven patients whose tumors could be identified through a cystoscope. Biopsy had proved that all seven were cancer. Subsequently, these patients died of cancer or showed evidence of deep invasion. In conclusion Colby said, "Evidence collected thus far gives little support to the cure of malignant tumor of the bladder by supervoltage irradiation."

The subject of metastasis from carcinoma of the bladder was studied by Colston and Leadbetter in 1935-1936. A patient who showed no gross evidence of tumor on cystoscopy or autopsy died of brain metastasis. Microscopic sections, however, revealed cancer in the deeper portions of the bladder wall which had not been eradicated by the apparently successful use of radium and deep x-ray therapy.

Complete removal of the bladder, usually along with the prostate and seminal vesicles, has been advocated by occasional operators for many years. We cannot attempt to discuss this large literature. The most important problem is diversion of the urine into the intestinal tract.

Uretero-intestinal implantation has been done for various conditions. Simon, of London, is credited with having effected an anastomosis between ureters and rectum as early as 1851. Thomas Smith carried out a similar operation in two stages in 18-8. Both patients died following operation. In Smith's case it was found that the left kidney was atrophic. The right kidney was hypertrophied, and the upper end of its

ureter was distended with urinous fluid. In 1892, Maydl transplanted into the sigmoid an ellipse of trigone bearing both ureters. Two years later Bergenhem transplanted extraperitoneally into the sigmoid one ureter at a time, with a rosette of bladder around the orifice. In the same year, Rein used glass tubes in the ureter to insure drainage and attached these to rubber tubes which were brought out through the rectum. The patient died from an unknown cause shortly after operation. Probably the first successful bilateral transplantation of the ureters after operation for carcinoma was by Chaput in 1896. In 1899, Peters employed Bergenhem's principle with ureteral catheters. In 1910, Coffey developed his submucous implantation in experimental animals. This technic was modified by Mayo, (1912) who used a catgut urine guide. Coffey applied his technic clinically in 1913. Cabot also modified Coffey's method by using an extraperitoneal approach (1921). Higgins, in 1933, modified Coffey's third type of implantation, by which the communication was established with transfixion sutures, and reported favorable results. Poth (1935) developed an aseptic method of uretero-intestinal implantation in two stages. At the second operation, each end of a long wire was passed up the ureter and through the uretero-intestinal septum into the bowel. These long, insulated ends were brought out through the rectum and a current applied. A longitudinal communication was thus established between ureter and bowel. In 1936, Hinman and Weyrauch published survey of the literature and collected more than 1,000 cases of uretero-intestinal implantation. Foley (1937) introduced his aseptic method.

The Coffey principle, with many technical modifications (Mayo, Cabot, Hinman, Lower and others), has received the widest acclaim. Kirwin (1930), experimenting with dogs, attempted to improve the operation but concluded that, so far as these animals were concerned, the basic design was unsound. Vermooten (1934)

also working with dogs, showed that the intramural portion of the ureter was almost always bathed in exudate when the Coffey operation was used. These observations have helped to explain the relatively high percentage of poor results with this method. Growing dissatisfaction with the existing mortality rate has led some operators to adopt simultaneous ureteral transplantation in two stages. The most recent proposal is that of Jewett (1940) who, at the first stage, imbeds the ureters into the bowel wall without going through the mucous membrane. At the second stage he divides the ureters below the point of implantation and inserts an insulated electrode with which he cuts through the tissues between the lumina of the ureters and bowel on each side. He then ligates and buries the cut ends of the ureters.

Uretero-vesical Implantation. Apparently the first recorded case of successful transplantation of ureters into the bladder was that of Israel (1896). Since then, this operation has been carried out with varying success. Among those reporting successful results by improved methods are Hunner and also Toulson (1939).

Tumor of the Testicle. Wilms (1896) demonstrated the teratomatous nature of most testicular tumors. Ten years later Chevassu described a tumor composed of cells which so closely resembled the cells of mature seminal epithelium that he believed it arose from the seminiferous tubules. To this tumor he gave the name seminoma. In 1911, Ewing, after an exhaustive study of pathological specimens, came to the conclusion that all the common tumors of the testicle are of a teratomatous nature. Perhaps the most comprehensive classification of testicular tumors is that of Hinman.

Trauma has long been considered a predisposing factor in the growth of these tumors for in a large percentage of cases, a history of injury can be obtained. Coley (1923) called attention to this fact. In 1925, Archie Dean published a series of eighty-four cases of tumors treated at the

Memorial Hospital. He concluded that simple orchidectomy usually is ineffective in achieving permanent relief, and that high voltage x-ray therapy also should be employed.

Hinman (1936, in Cabot's "Modern Urology") says: "Of 728 testicular tumors variously reported, 11.2 per cent were in undescended testes. Among 3,646 cases of undescended testis variously collected, there were only 8 instances of malignancy. The importance of statistics of this kind rests on their value in determining whether abdominal and inguinal retention predisposes the testicle to malignant change. At present this point remains unsolved."

In 1929, Zondek discovered a follicle stimulating hormone (Prolan A) in the urine of a patient suffering from teratoma testis. Ferguson (1933) made a quantitative study of this hormone in the urine of a series of patients with testicular tumors and believed that the type of tumor could be determined from the amount of hormone present. He was able to correlate the excretion of the hormone with the histological structure of the tumor in only thirty-seven of the 117 cases. Later work by Hinman (1935) and by Dean has shown that many patients with teratoma testis do not eliminate the hormone in the urine, but when the hormone is found in the urine, it is of considerable prognostic value, for its decrease under irradiation therapy is an index of radiosensitivity.

Chevassu (1910) unsatisfied with the poor results of simple orchidectomy, devised a radical operation for the removal of testicular tumors in which the entire lymphatic system from the testicle to the preaortic group of nodes around the kidney was removed. The technic of this procedure was modified by Hinman (1914). To the present day there has been some dispute concerning the advisability of confining the therapy to irradiation alone, but most writers believe that simple orchidectomy should be carried out first. The type of tumor can be then identified and extensive irradiation therapy commenced. Hinman

(1935) believes that the radical operation should still be employed in the case of radioresistant tumors if the patient is in good physical condition and presents no clinical evidence of metastasis.

Dean (1935) reports that in treating all types of teratomas by radiation he obtained five-year cures in 29.9 per cent. Dean (1935) and Randall and Bothe (1937) agreed that all cases of testicular tumor should be subjected to preliminary deep x-ray therapy. It was generally agreed that to be effective, the patient should have irradiation from the chin to the inguinal region whenever the biologic test shows the presence of metastasis.

In 1933, Hinman reported 17 per cent five-year cures in 109 cases which had been subjected to the radical operation. Twenty of the cases had been found to have inoperable metastasis, and forty-one of the other eighty-nine had preaortic metastasis. Four of these were known to be among the five-year cures. Among fourteen personal cases in which Hinman had carried out the radical operation, he stated in 1935 that ten patients were living from one to ten years. Seven of the fourteen patients had had metastasis, yet four had survived from one to fourteen years with good prognosis for further survival. "It is significant that eleven of the fourteen cases were the radioresistant mixed cell teratoma which otherwise would have been without hope." (Belt, 1937). Belt says that the radical operation undoubtedly has saved the lives of a number of individuals who had radioresistant teratomas, some with abdominal metastasis. It has been shown that the only hope for life in those individuals afflicted with chorioepithelioma or in those with a radioresistant tumor with cells of the adult type, is the radical operation.

Cabot (1939) studied the results obtained in 363 cases at the Mayo Clinic, of which he was able to trace 98 per cent, and reported the ultimate results. "One hundred and forty-eight patients were seen here in the first instance and the entire diagnosis and treatment was carried out at

the Clinic." These studies showed a survival rate after castration of 41 per cent for patients with carcinoma without irradiation at the end of five years and a survival rate of 27 per cent for ten years or more. Among the tumors which they classified as seminoma, "the survival rate for five years or more was 71 per cent of the fifty patients with seminoma treated with irradiation, and the survival rate of 47 per cent for the whole group whether or not treated by irradiation for a period of ten years or more. Two hundred and fifteen cases which were diagnosed and in many cases treated elsewhere, and came to the Clinic only for irradiation, were not included in the analysis."

HYPERTENSION

Hypertension has long been known to be associated with renal disease of many forms, but until recently it was believed that when renal diseases were responsible, they were always bilateral. Janeway (1909), Cash (1924), Wood and Ethridge (1933) produced hypertension in experimental animals by various methods involving injuries to the kidneys. Tigerstedt and Bergmann (1898), Prinzmetal and Friedman (1910), Harrison, Blalock and Mason (1936) all had produced hypertension by extracts from normal and diseased kidneys. Longcope and Winkenwerder (1933) in a series of patients demonstrated the relationship between hypertension and contracted kidneys due to chronic bilateral pyelonephritis.

Goldblatt and his co-workers (1937) produced hypertension experimentally by a partial constriction of the main renal arteries by means of a clamp. In 1937, Allan Butler reported two cases of hypertension in children associated with unilateral chronic pyelonephritis. In these patients the blood pressure returned to normal after nephrectomy and was still normal after twenty months in one case and three months in the other. N. M. Barker and Waltman Waters (1938) reported a case of unilateral atrophic pyelo-

nephritis in an adult in whom nephrectomy was carried out. Following this the hypertension which was present is reported to have been cured. That same year Leadbetter and Burkland reported a case of ectopic pelvic kidney in a five and a half year old colored boy who had hypertension. The urine was uninfected. The function of the ectopic kidney, as shown by excretory urography, was somewhat impaired. Nephrectomy was carried out solely for the purpose of reducing the high blood pressure. Subsequent examinations have shown the pressure to have remained normal. Pathological study of the specimen disclosed a partial occlusion of the main renal artery by a smooth muscle plug springing from its wall. Another case of hypertension was reported at the same time by Boyd and Lewis. Removal of one kidney in which marked vascular changes had resulted in an infarct restored the blood pressure to normal.

The wave of enthusiasm for subjecting many patients with hypertension to nephrectomy resulted in a word of caution by Crabtree and Chaset (1940). In a series of 150 cases of severe unilateral renal damage, only fourteen patients had hypertension. In all except four of these, the removed kidney showed vascular lesions. Of these four cases without arterial changes two of the patients were sixty years old or more.

Braasch, Walters and Hammer (1940) have reported the results of an extensive study of unilateral atrophic pyelonephritis and have shown the relationship between this condition and hypertension. In their cases there was marked renal vascular disease.

Koons and Ruch (1940) reported one case of hypertension associated with Wilms tumor. Nephrectomy restored the pressure to a normal level.

UROGENITAL TUBERCULOSIS

Renal Tuberculosis. Since 1890, bilateral renal tuberculosis has been a frequent subject of discussion. At first, as shown by the papers of Casper (1900), Hallé and

Motz (1902), Albarran (1905), Israel (1911) and Legueu (1915), it was believed that only 10 to 20 per cent of cases showed bilateral involvement. With the advance in diagnosis, however, the percentage has been rising to agree more nearly with the autopsy findings of approximately 50 per cent bilaterality (Rafin, 1914; Medlar, 1926). George Walker (1911) proved the bilateral nature of early renal tuberculosis in rabbits by the intra-aortic inoculation of tubercle bacilli.

Lieberthal (1938) in agreement with Chute (1920) and Medlar (1926) published his theories of the development of renal tuberculosis based on autopsy, clinical, surgical, pathological and experimental evidence. He believes that the invasion of the kidney is usually by blood-borne organisms which cause lesions in both kidneys at the same time and in several places, many or all of which may heal. A single remaining focus may finally erode the epithelium and discharge bacilli into the urine, undiscovered because at this stage there are no urinary symptoms. However, some of them lodge at the apex of a papilla and form a small ulceration. Adjacent arteries may be eroded and produce miliary seeding of the cortex. As the result of bacilluria, edema and stricture of the ureter occur, causing stasis and reimplantation on other papillae. Cystitis also follows the continual flow of bacteria and bacterial products.

Whether retrograde infection of the kidney can occur is still controversial. In 1892, Albarran, by injecting tubercle bacilli into the ligated ureter, proved that retrograde infection could occur, but he felt that ureteral reflux was a necessary condition. This has been confirmed by numerous workers, including Hallé and Motz (1904), Bauereisen (1910) and Lieberthal (1938). The contrary view has been taken by G. Walker (1911) and Kenneth MacFarlane Walker (1913). Beer (1917) reported positive guinea pig inoculations with urine obtained from supposedly normal kidneys; the result, he thought, of contamination or regurgitation. In a later report with Moss,

Braasch (1930) concluded that positive reports of tubercle bacilli from normal kidneys were caused by regurgitation and asserted that ascending infection of the ureter from a badly infected bladder is the usual cause of regurgitation. In recent years as studies improved, recognition of kidney involvement has increased.

In 1917, Fenger described tuberculous ureteritis and the associated "golf hole ureter." In 1918, Young described retraction of the ureter and characteristic changes in the trigone in renal tuberculosis which sometimes go on to complete undermining of the trigone.

Between 1890 and 1900 various operative procedures for kidney tuberculosis were undertaken including nephrotomy, partial resection and nephrectomy by lumbar and transperitoneal routes. With the gradual improvement in diagnosis which made it unnecessary to expose the "good" kidney, the transperitoneal route has been discontinued. Notable among the pioneers were Israel, Albarran, Tuffier and Morris. In 1900, O. G. Ramsay proved that nephrotomy and partial resection, while affording immediate relief, were accompanied by a higher remote mortality. This had also been shown by F. L. Facklam (1893). During the next ten years the immediate mortality of nephrectomy dropped steadily. Brodeur (1890) admitted a mortality of 58 per cent, Palet (1893) 40 per cent; Pousson (1902) 28.4 per cent, Wildbolz (1913) 2.8 per cent, Beer and Hyman (1920) 207 cases, 3.8 per cent, Barney (1925) 3 per cent, Young (1926) 111 cases with no deaths, (patient no. 112 died) and Caulk (1936) .7 per cent.

Since 1910, surgeons have concerned themselves with attempting to decrease the number of postoperative sinuses. Israel (1896) and Røvsing (1896) anchored the ureter into the anterior angle of the wound for subsequent irrigation. W. J. Mayo (1915) readvocate this. Borelius (1911) mentioned that he had closed several incisions tightly without drainage, and in 1912 W. J. Mayo also advocated tight closure,

after lavage of the wound with normal saline. Keyes (1939) is at present the foremost advocate of the latter procedure, and T. L. Howard (1939) of the former, both of which were popularized by Mayo. At present, the almost universal procedure seems to be to ligate the ureter as low down as possible, sometimes after the injection of 95 per cent carbolic acid. Drains are usually inserted. Numerous authors (Kelly, 1914; Caulk, 1936; and T. Leon Howard, 1939) substantiate these views. H. L. Kretschmer (1916) and Caulk (1936) emphasize the importance of removing the fatty capsule to prevent sinus formation.

Complete nephroureterectomy including a cuff of bladder was advocated by Kelly (1896) using two incisions. Others (Beer, 1921) have also used two incisions, but Caulk (1936) and others state that this procedure is unnecessary and merely adds to the difficulty of the operation.

Conservative treatment (sanatorium care and tuberculin) has been advocated for renal tuberculosis, mainly by G. J. Thomas, et al. (1938). However, most authors (according to Caulk, 1936) prefer to use conservatism only in those cases with bacilluria and no ulceration performing nephrectomy as soon as advancement of the lesion is definitely demonstrable. Parsons (1925) showed that 85 per cent of eighty-four unoperated cases were dead in five years. Wildbolz (1929) advanced this to 94 per cent of 316 cases in ten years. He presented cases of tuberculous nephritis which had apparently become arrested or cured without resort to operation, but on the other hand he quoted various authors to show that in definite ulcerative tuberculosis of the kidney, the nonoperative treatment was rarely successful. Wildbolz states definitely that clinically demonstrable caseous renal tuberculosis never becomes completely fibrosed or healed. Wildbolz agreed with Persson, Rafin, Judd and Scholl that nephrectomy never brings a cure in bilateral renal tuberculosis, nor even prolongs the life of the patient. Young (1939) recounted the case of a man with

early renal tuberculosis who, after three years of the best sanatorium care and tuberculin, returned to him dying of extensive genito-urinary tuberculosis. This would seem to be rather typical. Emmett and Kibler (1938) state that in their large series of nephrectomies for tuberculosis the prognosis in regard to the good kidney is dependent upon the severity of involvement as measured by the number of white cells in its urine obtained by ureteral catheterization, in spite of negative pyelograms.

In 1890, it was already known that the bladder symptoms would usually subside after removal of the infected kidney, but only some time later was it definitely proven that in most cases the bladder symptoms were secondary to renal tuberculosis (George Walker, 1907).

In regard to the treatment of the bladder symptoms following nephrectomy, Rovsing (1907) recommended the instillation of 6 per cent carbolic acid. Vernier (1913) recommended ether vapor and Farnarier (1914) iodine vapor. Various other topical applications have been highly praised. Among these are gomenol, silver nitrate and mineral oil. Caulk and Ewerhardt (1932) recommended intravesical ultraviolet light, which they applied with a special instrument, obtaining a startling result in the one case cited.

Genital Tuberculosis. Guyon (1891), the father of modern urology, in discussing the question of genital tuberculosis, stressed the great frequency with which the seminal vesicles and prostate were the primary seat of the involvement. As a result of a study of 220 cases, he concluded that the disease most often traveled down from the seminal vesicles and prostate to involve the epididymes.

Since Guyon's article, the literature has contained many papers on the development of genital tuberculosis. There is one group who believe that in the majority of cases the seminal vesicles become involved earlier than the epididymes; another group have been just as strongly impressed with the opposite view. The reader is referred to

an exhaustive paper by Barney (1936) in Cabot's "Modern Urology" which has a full and a fair discussion of the subject.

In 1901, Young collected from the literature thirty-two cases in which operations upon tuberculous seminal vesicles had been carried out. He came to the conclusion that the results were generally bad and therefore advised against this radical operation. This stand was further strengthened by reports from Kocher's clinic which showed that after excision of tuberculous testicles, the remaining process in the seminal vesicles and prostate in many instances became so much improved as to give very little trouble. Articles by Bardenheuer (1887) and Keyes (1892) showed good results from simple epididymectomy.

A paper of great importance by George Walker appeared in 1911. He conducted a long series of experiments on rabbits by injecting tubercle bacilli into various genito-urinary organs or into the blood stream. Following intra-aortic injection, Walker found that the kidney and epididymis were most frequently the site of localized tuberculosis. Rarely was there any localization in the prostate or vesicles, but when it did occur, the epididymis might become involved later. Walker also found that when the initial lesion was in the kidney, the seminal vesicles and prostate might also be involved from that source.

Kenneth MacFarlane Walker (1913) also carried out experiments with guinea pigs and concluded that when tubercle bacilli were placed into the anterior urethra, the infection often reached the epididymis by the lymphatics and not by the vas deferens.

For ten years, epididymectomy was the procedure followed by Young and his associates. In some cases the tuberculous process in the prostate and vesicles did undoubtedly retrogress so as to become almost negligible, but frequently the outcome was not favorable. A careful study of these cases showed many in which the patient gradually became worse, the urethra and bladder were involved and

death gradually ensued from generalized tuberculosis.

Young (1918) stated that he had again considered the question of the operation upon the vesicles and had developed a new technic with a long prostatic tractor that could be introduced through the urethra. With this to draw the prostate and vesicles toward the perineum, he found it much easier to remove the vesicles, ampullae and lateral lobes of the tuberculous prostate.

In 1922, Young in an exhaustive paper reviewed the literature on the pathology of dissemination of genital tuberculosis and presented fifteen cases in which the radical operation had been done. In five nephrectomy also had been carried out. There were no operative deaths. One patient died from tuberculosis a year later; the others were thought to be completely arrested.

Other papers reporting radical operations are those of Whiteside (1914, 1919), twenty-two cases; Quinby (1918), seven cases; Hinman (1928), thirteen cases; Young (1936), fifty cases. In this latter paper Young expressed the opinion that but for the radical operation, which in one-fourth included nephrectomy, many of these patients would have died.

After a very thorough analytical study of the literature, Barney (1936) stated:

There are two schools of thought as to the origin of the lesion, it being at variance for many years. I believe that while the vast majority of cases are adequately treated by conservative surgery, there may be cases in which the radical operation might be indicated. Some of the radical surgeons feel equally open-minded. The burden of proof still rests with Young. . . . Let none of us forget . . . that the patient has tuberculosis elsewhere. . . . One must not be surprised if a fresh outbreak of the disease suddenly develops or some one of its terminal forms.

OBSTRUCTIONS

Upper Urinary Tract. The various obstructions to the flow of urine through the urinary tract, either mechanical or neuro-

genic in origin, have their greatest significance in the ultimate effect on the kidney. The term hydronephrosis appeared first in Rayer's "Traité des Maladies des Reins" (1841). Since then the condition has been described at autopsy and at operation by a multitude of writers. Attention has been directed principally to the study of the various causes of obstruction. Kelly (1914) concluded that abnormal mobility of the kidney was the commonest single cause. Young (1926) reported a series of 100 unilateral supravescical obstructions and found ureteral stricture present in forty-six, calculi in thirty-nine, movable kidney the cause in four; in nine cases, no definite cause was observed. Since then, other writers have tabulated a complete list of mechanical and neurogenic causes of obstruction. The most extensive work on the nature of hydronephrotic atrophy is that of Hinman who commenced a long series of experiments in 1918. He and his co-workers thus were able to contribute an enormous amount of valuable information to the clinical problem which is briefly and clearly presented in Hinman's "Principles and Practice of Urology" (1935).

Küster is given credit for having performed the first successful plastic operation for the relief of hydronephrosis. In 1891, he transplanted a strictured ureter to the most dependent part of a hydronephrotic sac with complete success. Fenger (1892) relieved a ureteral stricture by dividing the area of stenosis longitudinally and closing transversely—the Heineke-Mikulicz principle. Subsequently, Fenger elaborated other methods of plastic repair of the hydronephrotic sac and ureter. Cramer (1893-1894) after a longitudinal division of the ureter and adjacent part of the pelvis approximated the corresponding lips. Israel (1896) and also Kelly advised plication and other technics upon the dilated pelvis. After this many surgeons reported plastic work for strictures at the ureteropelvic juncture, but generally without success.

W. J. Mayo (1909) reported twenty-seven cases in which he had divided vessels as well as carried out plastics for obstruction at the ureteropelvic juncture.

Schwytzer (1923) published his Y-plasty operation for hydronephrosis "which he had done first in 1916" (Foley, 1937).

In 1923, Quinby reported cases in which he had reimplanted the ureter in the most dependent portion of the pelvis to avoid ligation of the vascular cord. Papin (1928) and Walters (1930) described various methods of resection of the hydronephrotic sac. In 1928, Keyes reported a successful plastic repair by intubation of the ureter. He divided the stricture and left a tube for drainage until closure was effected.

In 1937, Foley described his technique of Y-plasty for stricture at the ureteropelvic juncture and cited nineteen personal cases.

In 1932, Young reported a case of a very large hydronephrosis caused by obstruction to the ureter with a vascular cord, in which he avoided both division of the blood vessels and transplantation of the ureter by resection of large areas in the anterior and posterior walls of the pelvis. This procedure greatly reduced the size of the pelvis and in closing pulled the ureter away from the blood vessels.

Walters, Cabot and Priestley (1937) reported the results obtained in seventy-one plastic operations of various types in hydronephrosis.

Nephrostomy and ureterostomy are described elsewhere.

Stricture of the Ureter. The literature on the subject is so extensive that I can refer only briefly to it. Much of it is due to Hunner's announcement in 1911 that stricture of the ureter was particularly common in women as a result of remote focal infections. His insistence on the importance of searching for and removing such focal infections has met with general agreement, but as to the frequency of ureteral stricture, there is still much disagreement. Schreiber (1927) could not find a single instance of localized intrinsic inflammation of the ureter which could be regarded as

metastatic in character resulting from focal infection (Hinman, 1935). Nixon (1929), Frater and Braasch (1929) found no inflammatory strictures in 144 autopsies. Carson (1927) found four secondary inflammatory strictures in 185 consecutive autopsies. On the other hand, there are a great many papers in which the value of ureteral dilatation for stricture is stoutly maintained. Hunner, after an experience of several thousand cases, is equally insistent on the correctness of his stand.

Lower Urinary Tract. One of the early investigators on the embryology of the prostate was Pallin (1901). Herzog (1904), von Lichtenberg (1906) and Paschkis that same year contributed important papers on embryology. Lowsley (1912) reported the results of his investigations on the embryology. He found five distinct groups of tubules springing from the posterior urethra from which the five prostatic lobes developed. Ernest Watson (1918) described the development of the seminal vesicles, and Wesson (1920) presented an important paper on the embryology and physiology of the prostate, and particularly the trigone. Franklin Johnson (1920, 1922) presented papers on the development of the urethra and the homologue of the prostate in women.

Even brief reference to the great numbers of papers on the prostate and its various diseases is impossible. We shall pass to the subject of prostatic obstruction.

Among the many papers on the development of the obstructive prostate may be mentioned the pioneer work of Albarran (1902) and Motz (1905) who demonstrated that prostatic hypertrophy arose from the submucosal glands. Tandler and Zuckerkandl (1912) contended from their studies that the hypertrophic process commenced in the middle lobe and encroached upon and compressed the other portions of the gland. In 1923, Simonds agreed that the submucous glands were the structures that actually underwent hypertrophy, while the prostate proper became atrophic. In 1931, Alexander Randall presented his important

volume, "Surgical Pathology of the Prostate." Laqueur (1934) ascribed hypertrophy of the prostate to an imbalance between male and estrogenic hormones in the blood. MacCallum (1937) presented a classic review of "Pathological Physiology of the Prostate," with a bibliography of more than 150 references. In 1940, after an exhaustive study, Deming came to the conclusion that solid fibromuscular masses in the wall of the prostatic urethra stimulated the prostatic ducts to undergo hyperplasia.

Prostatectomy. We have already mentioned Belfield's pioneer work on suprapubic prostatectomy. McGill, and Fuller (1895) followed closely and improved upon Belfield's technic. Young reported more complete enucleations through the suprapubic route when the prostate was pushed up by the insertion of a gloved finger in the rectum, and in 1900, Guiteras presented this method to the International Medical Congress in Paris, where the principles were seized upon by Freyer of London who a few months later presented the method as his original technic. With great enthusiasm he followed his initial report by additional papers with a rapidly increasing number of cases. It was not long before the operation was called "Freyer's suprapubic prostatectomy" and had been adopted throughout England and the continent. It is still widely known by his name, although the technic had been employed in America for several years before it was described by Freyer.

Bentley Squier (1911) made an important contribution to prostatic surgery when he introduced the intraurethral method of enucleation of the hypertrophied lobes.

In the ensuing years the literature was filled with reports on suprapubic prostatectomy with slight modifications here and there, the object being to make the operation more safe, to avoid fatal infections and hemorrhages. One of the most important of these was Hagner's (1914) hemostatic bag, modified later by Pilcher (1917).

Lilienthal (1902) advocated carrying out suprapubic prostatectomy in two stages, one for drainage of the bladder and the other for removal of the prostate. Keyes and others modified this technic, but introduced three or more stages, the object being to prevent suprapubic infiltration and infection. By these various procedures the mortality and ultimate results of suprapubic prostatectomy were gradually improved. Thomson-Walker advised more extensive resection of tissue at the vesical neck, particularly in the region of the trigone. The use of sutures was introduced by Judd (1916) and more complete suture of the prostatic bed was brought out by Harris, of Australia. Among the later writers, Lower (1927) has advocated the two-stage operation and the efficacy of the suprapubic route for prostatectomy. The operation has undoubtedly a very definite position and value.

Perineal prostatectomy has an even longer and more complex history than the suprapubic route. Some of the very early lithotomists occasionally extracted a prostatic lobe through the perineal incision made to remove a calculus. The most important work on this subject was a beautiful monograph by F. S. Watson who, in 1888, presented remarkable pathological specimens and reports of the enucleation of prostatic enlargement through a median perineal incision. In 1891, Goodfellow appeared upon the scene and enthusiastically advocated enucleation of the hypertrophied prostate through a median perineal incision. The operations he did largely under spinal anesthesia which had recently been introduced in America. Goodfellow's operations, carried out in various clinics over the country, led to a wide usage of his technic.

Others advocated perineal prostatectomy through a median incision, but with the mounting accumulation of cases it soon became evident that perineal prostatectomy by the methods then in vogue had many drawbacks. The median perineal incision passed back through the bulb, and the

external sphincter, and was often followed by complete incontinence. Through this incision the finger was introduced and as much of the prostatic hypertrophy as could be reached enucleated. Subsequent results and autopsies showed that intravesical growths, particularly large median lobes, were frequently left behind. To obviate this, various procedures were suggested; viz., pressure upon the abdominal wall to push down the prostate, a suprapubic incision down to the bladder through which the hand was introduced to push down the prostate, and opening the bladder suprapubically (Nicol, 1894) and the insertion of the hand to push down the prostatic lobes. As all these had their objections, Albarran introduced a "desenclaveur" which he passed into the bladder through a median perineal incision and used to draw down the prostate, which he enucleated through the median incision. Parker Sims (1902) introduced his intravesical balloon which passed into the bladder through a median perineal incision, was inflated and used to draw down the prostate to the enucleating finger in the perineum. Andrews (1902) brought out a fenestrated sound which was passed through the perineal wound and was used to draw down the prostate in a similar way. Proust (1901-1903), of Paris, introduced a curved incision through which the operator reached the prostate back of the transversus perinei muscles and thus avoided injury of the triangular ligament and external sphincter. His dissecting technic was a great improvement upon previous methods. Reaching the prostate, it was bisected, grasped with forceps and removed from within the capsule. Young (1903), who had previously been employing the methods of Alexander (1894) for removing a prostate through the perineum, brought out his double bladed tractor to draw down and facilitate the enucleation of the prostate which had been exposed behind the triangular ligament and external sphincter, both of which were carefully preserved. In order to prevent injury to the veru-

montanum and ejaculatory ducts, Young employed a bilateral capsular incision through which the lateral lobes were first enucleated and then the middle lobe. The ability to see what one was doing, to arrest hemorrhage, to pack the wound to stop oozing, and the obtaining of excellent two-way tube drainage, as well as the great reduction in mortality (one series of 198 cases without death was reported) at once recommended the operation.

Space prevents even mention of the various modifications subsequently offered by Young and his associates and by Hinman, Cecil, Edwin Davis, Belt, Wildbolz, Geraghty and many others. At present, the technic most commonly employed is to open the urethra directly through the prostate for the introduction of a tractor and enucleation of the lobes through an inverted v capsular incision, and approximation of the vesical neck with the prostate below by mattress sutures of catgut around a tube draining the bladder which is also drained with an inlying urethral catheter. With adequate preoperative treatment, referred to elsewhere, careful hemostasis, hydrotherapy by mouth or intravenously, and the modern use of chemotherapy, the operative mortality has been greatly reduced, so as to be now almost nil. As the patients are often aged and have various complications, occasional deaths from intercurrent disease cannot be avoided, as after other prostatic operations in the young.

Cancer of the Prostate. Albarran (1898) was the first to call attention to the great frequency of cancer of the prostate. In a classic paper with Hallé he reported the study of 100 cases of supposedly benign prostatic enlargement in which malignant changes which he called "epithelioma adenoide" were found microscopically. This publication aroused considerable interest, and, at the Johns Hopkins Hospital, Geraghty made a careful study of the specimens removed by prostatectomy or at autopsy and concluded that many of the changes described by Albarran were not

true carcinomas but were frequently seen in benign prostatic adenomas. Young (1905) reported that approximately 20 per cent of the patients who came for prostatic obstruction had carcinoma. In 1906, he and Geraghty described the pathology and reported that carcinoma was found far more frequently in the posterior lobe, whereas adenomatous hypertrophy occupied the lateral and median lobes. The two diseases often existed at the same time, each separate and distinct from the other. Young reported that in about 50 per cent of the cases of carcinoma of the prostate, benign adenoma of a different portion, generally lateral and median, was present. The frequency of carcinoma of the prostate was confirmed by Wilson and McGrath of the Mayo Clinic, and others. It was not until 1935 that Rich published his series of 292 consecutive autopsies in which he found carcinoma present in about 14 per cent of men past forty-one years of age. This paper was published in the *Journal of Urology*, and along with it Moore reported 242 cases in which carcinoma was found in routine autopsies of men over forty-one years of age, and an even larger percentage of the cases (18 per cent).

Radical Operation for Carcinoma of the Prostate. In 1904, Young proposed and carried out the first really radical operation for carcinoma of the prostate. The entire prostate, with a cuff of the bladder, both seminal vesicles and ampullae were removed in one piece and anastomosis between the bladder and membranous urethra carried out. In the early cases, incontinence resulted, but by modifying the technic, Young reported that in some cases normal urination followed. Other types of suture employed by Jewett, Lewis and by Vest in an effort to avoid ligating the external sphincter resulted in more frequent restoration to normal urination. G. G. Smith advocated the employment of Young's radical operation, not only in cases sufficiently early to expect a radical cure, but even in more advanced cases in the hope of

giving the patient a more comfortable life even though he died of metastases. In Young's statistics in which he recently reported nearly 100 cases were some in which the prognosis was not good on account of the size and extent of the carcinoma. Regardless of this, very careful study of the ultimate results showed that in about 50 per cent of the cases followed over five years after leaving the hospital no recurrences were reported, many of the cases having been followed over ten years, and one twenty-six years. To the surprise expressed at the almost unbelievably high percentage of cures it was pointed out that the prostate with its capsule and two surrounding fascias offers more resistance to the progress of carcinoma and therefore a better prospect for radical cure than almost any other organ in the body.

For cases of very early carcinoma with a small nodule in only one lobe of the prostate, a less radical operation in which half of the prostate with the seminal vesicle and ampulla above are removed has been carried out in a few cases. The typical completely radical procedure is, however, considered the method of choice; and if medical practitioners could be impressed with the frequency of carcinoma of the prostate and be induced to make more frequent rectal examinations, even in the absence of symptoms, it is held that radical operations in carcinoma of the prostate would give an even higher percentage of cures.

Contracture of the Neck of the Bladder. This condition was recognized by urologists of over a century ago and Mercier devised several instruments for dividing such a bar. This operation, which before the days of urethroscopy and cystoscopy was done blindly, was often accompanied by severe hemorrhage, generally did not remove the obstruction and fell completely into disuse. With the improvements made in Bottini's electric cautery incisor by Freudenberg and in America by Chetwood, contractures at the vesical orifice were frequently treated by burning through the obstruction in one

or more places with an electric cautery knife which traveled in an outer or female beak similar to a lithotrite. But these methods fell into disuse, and such conditions usually were operated upon through a suprapubic incision, the bar grasped with forceps and cut away with scissors.

It occurred to Young in 1909 (1913) that this was an extensive operation to remove so little tissue, and he designed his "urethroscopic prostatic excisor" or punch to remove these obstructive masses of the obstructing tissue at the vesical orifice. In 1917, Young presented 156 cases with an exhaustive pathological report prepared in conjunction with Howard Cecil, in which the different pathological types of these contractures and bars were given in detail. There was no mortality and the simplicity of the operation was striking. In order to minimize the hemorrhage, Young (1912) presented an electrocautery prostatic excisor or punch in which a platinum ring was heated by electricity to a white heat and removed the tissue entrapped in the fenestra. In 1920, Caulk modified Young's instrument and extended the use of the punch to all types of prostatic obstruction, even those characterized by great hypertrophies. He became an enthusiastic advocate of the cautery punch operation. He eventually presented a great series of hundreds of cases with very little mortality. In the meantime, Braasch (1918) had modified Young's punch by providing a light in the inner curved beak instead of externally. Several years later Bumpus (1926) improved Braasch's instrument. Thompson provided the Braasch-Bumpus instrument with a tube along its roof to carry an insulated wire with which to fulgurate bleeding points. With these instruments, Thompson has reported a very large series of cases in which, by transurethral prostatectomy, he has not hesitated to operate upon even the greatest enlargements.

In the meantime, Stern (1926) had modified Young's original instrument by providing a high frequency loop and a

cystoscope of the McCarthy foroblique type. With this "resectoscope" he carried out excision of the prostatic tissue which was caught in the fenestra, as with Young's cold cutting punch. Collings (1926) introduced his "electrotome" for excising obstructing bars. Stern's methods were adopted and used in a considerable series of cases by Theodore Davis (1931) who introduced certain mechanical improvements. In 1932, McCarthy modified Stern's resectoscope by leaving off the fenestra and adopting a tube somewhat similar to that of his panendoscope (1910). The resection of prostatic tissue was carried out by a loop heated to incandescence by high frequency current, and bleeding points were fulgurated by a coagulating current. McCarthy's instrument has been the one employed generally, especially by Alcock, who has presented the greatest number of cases.

Many thousands of cases have now been successfully operated upon by the Young urethroscopic prostatic excisor or punch, Caulk's cautery punch, the Braasch-Bumpus-Thompson punches, and by the electrified loops of Stern and McCarthy. There is a large group of urologists who employ urethroscopic resection of the prostate in almost all cases, benign or malignant, small or large; but there is also a large group who, dissatisfied with the results obtained by transurethral resection, have been urging more and more forcibly the use of prostatectomy, especially in the larger hypertrophies. Among these may be mentioned Hinman, Cecil, Edwin Davis, Belt, Shaw, G. G. Smith, Lewis, Colston.

Obstructions at the Vesical Neck in the Female. In 1921, Caulk presented the case of a woman with frequent and painful urination. Cystoscopy showed a marked thickening in the posterior margin of the vesical neck associated with bullous edema of the urethra. With his cautery punch, Caulk removed a large piece of tissue posteriorly from the vesical neck, and the specimen showed dense sclerosis. The patient was cured. Arthur Chute (1929)

related a case in which he had removed obstructing flaps at the vesical neck posteriorly through a suprapubic incision. Nesbit (1933) reported three cases in which he had removed the obstruction with the McCarthy resectoscope. In 1933, Papin reported having carried out suprapubic excision of the obstruction at the vesical neck. Fite (1934) reported a case cured by resection with the McCarthy instrument. Van Houtum (1935) described six cases which were treated by the Caulk cautery punch. Gershom Thompson (1935, 1939), Friedrich (1935) and Winsbury-White (1936) reported subsequent cases. In 1937, Caulk said that obstructive conditions at the vesical neck in the female were relatively common. He reported twelve cases in which with his cautery punch he had removed obstructive inflammatory tissue at the vesical orifice with excellent results. In 1934, Folsom and Alexander had called attention to the frequency of inflammatory conditions in which the suburethral glands played an important part. In 1938 and 1940, Young reported a pathological study of his cases which showed that the glands described by Franklin Johnson (1922) as the homologue of the prostate in the female were the seat of inflammatory changes associated with obstructions at the vesical neck in women.

Congenital Valves of the Prostatic Urethra. Although this condition was first described by Morgagni in 1717 and several cases were found at autopsy by Englisch, apparently the first case in which the valves were recognized in life and seen with a cystoscope was one of Young's in 1912. The valves were destroyed by urethral instrumentation with improvement in urination. The patient died of pneumonia later. Autopsy showed the valves, which had been ruptured, and marked dilatation of the ureters and renal pelves. In 1913, in a case in which it was impossible to pass instruments into the bladder, Young carried out a suprapubic operation, saw congenital valves through the dilated vesical neck and excised them, with a cure.

These cases were reported at the Johns Hopkins Medical Society in November, 1913, but did not appear in print until 1919 when Young, Frontz and Baldwin described twelve cases. Randall (1921) was the first to carry out fulguration of congenital valves. Hinman (1925) reported four cases treated by fulguration. In 1935, Counseller and Menville reported a case, and Keyes also reported a case that same year. Fagerstrom reported two cases in 1937. In "Genital Abnormalities, Hermaphroditism and Related Adrenal Diseases," Young published a study of thirty-two cases. The punch operation with excision of the valves had been carried out in twelve cases. Suprapubic cystotomy and destruction of the valves had been done in twelve cases. The valves were ruptured by passage of urethral instruments in two instances. There was no operative mortality. Six patients were not operated upon. In 1936, Campbell described minute instruments for electrical resection of posterior urethral valves through a child's cystoscope.

Congenital Hypertrophy of Verumontanum Simulating Valvular Obstruction. This condition may be responsible for obstructive symptoms and serious changes in the upper urinary tract, such as are seen with congenital valves. The subject was well discussed in a paper by Bugbee and Wollstein (1923).

Stricture of the Urethra. As stated before, the diagnosis and treatment of stricture of the urethra had made great advances before 1890; in fact, no outstanding contributions have appeared since then. Marion, and Cabot, and MacGowan (1923) strongly advocated radical resection of excision with anastomosis in certain cases. Keyes (1936) considered these methods unnecessarily radical. Geraghty (1906) studied a series of 400 cases. Retrograde operation for perineal stricture of the urethra, which had been introduced by Cock, was modified and improved by Young (1926). In 1929, Campbell reported 1,244 cases of which 848 without extravasation were subjected to operation. The mortality was 4.9 per

cent. If 114 cases complicated by extravasation were added, the mortality would be increased to 10 per cent. Of 396 patients not operated upon, thirteen died. In 1930, Lowsley advised preliminary suprapubic drainage in certain cases of stricture of the urethra. In 1931, Caulk reported that in 1,320 cases of stricture, he had performed urethrotomy forty-five times. Open operation was resorted to in only 3.4 per cent of all strictures encountered, and only 0.6 per cent in simple uncomplicated cases of stricture. In 1933, Riba and Sanner presented an electro-urethrotome for the treatment of strictures of small caliber. The subject of urethral stricture and its complications was exhaustively discussed by Keyes in Cabot's "Modern Urology," 1936.

Diverticulum of the Bladder. The operative history of diverticulum of the bladder began with a case reported by Pean (1895). He excised a supernumerary urethra and a diverticulum per vaginam in a girl of fifteen years; the operation was followed by recovery and cure. Czerny (1896) removed a large diverticulum extravesically through a transverse abdominal incision; the ureter was transplanted. An abdominal urinary fistula resulted, necessitating nephrectomy. The third case was reported by Riedel (1902) who removed a diverticulum extravesically, also through a transverse suprapubic incision. The patient died of collapse. Two years later Pagenstecher reported the fourth case. He went in posteriorly, resected the sacrum, pushed the rectum to one side, excised the diverticulum and transplanted the ureter. The final result was a urinary fistula in the sacral region. The fifth case was that of von Eiselsberg who removed a small diverticulum on the vertex of the bladder extravesically. In 1904, Young operated upon the sixth case and removed a large diverticulum extravesically through a median suprapubic incision. In this case, the orifice of the ureter opened into the posterior wall of the diverticulum. Young carried his line of excision around the ureteral orifice so as

to preserve a flap of vesical mucosa. This along with the orifice of the ureter were drawn into the bladder which was closed by sutures in the form of a Y. Young subsequently reported six cases in which he had avoided transplantation of the ureters by this simple plastic procedure. In another diverticulum, present in the same case, Young, for the first time, enucleated a diverticulum transvesically, a method which he has since employed in approximately sixty cases, sometimes with the assistance of suction to draw the diverticulum into the bladder.

Ernest Watson (1920) presented his observations in regard to the etiology of diverticulum of the bladder.

In a recent report John Dees (1940) has analyzed ninety-five cases of diverticulectomy from the records of the Brady Urological Institute.

Kretschmer (1940) reported an exhaustive study of 236 cases of diverticulum of the bladder. In addition, he appended a complete bibliography. His conclusions are that "some diverticula usually do not require removal. In large diverticula, if the ureter is obstructed and pyuria does not clear up, there are no recurring attacks of fever and urinary symptoms, or if the diverticulum does not empty, diverticulectomy should be done. Large diverticula should be removed." Usually Kretschmer does this operation first and performs resection, if indicated, later.

ANOMALIES OF THE UPPER URINARY TRACT

This subject is so vast and has occupied so many investigators in the anatomy, physiology, pathology and surgery of the conditions described that in this review it is impossible to refer to the many splendid papers and books on the subject. A masterly survey of the many aspects of this great subject will be found in Hinman's "Principles and Practice of Urology," 1935.

Pohlman (1904) showed the embryological basis for many anomalies of the

kidney. Since then there have been innumerable reports in the literature. Many surgical procedures have been designed to correct the disturbed anatomic relations.

Double Kidney. Various investigators report that 3 to 4 per cent of autopsies show double kidneys (Eisendrath, 1923). Mertz (1920) found 80 per cent of double kidneys to show pathologic conditions. Braasch and Scholl (1922) reported that 54 per cent of their 144 patients with various degrees of duplication of the kidney on one or both sides had definite pathologic complications.

In 1933, Mathé carefully studied operations for partial nephrectomy or resection of the kidney. In 1912, Braasch reported that W. J. Mayo had removed the hydronephrotic half of a kidney secondary to an anomalous blood vessel, a similar sac secondary to stricture at the vesical wall and a hydronephrotic half containing a stone. According to Mathé, "Young reported the first deliberate successful resection of a double kidney. He removed the lower half of the kidney containing a calculous pyonephritis in which it was determined to carry out the operation after pyelographic study."

Following this report there was a tremendous impetus for conservative operations. In 1923, Eisendrath presented a study of eighty-two cases of double kidney in which the surgical intervention consisted of nephrectomy, fifty cases; heminephrectomy, twelve, partial pyelectomy and nephrotomy, twelve, and subsequent removal of the remaining half following heminephrectomy, six cases. In 1925, Phifer reported a case of bilateral heminephrectomy. That same year Judd reported eight cases of heminephrectomy. Walters also championed conservatism in renal surgery. Heminephrectomy in horse-shoe kidney was reported by Rovsing (1911), Brongersma (1919), Rawlings (1921), Kidd (1922). In 1924, Rathbun collected fifty-two such operations with only eight deaths, a mortality of 14 per cent. Since then, other papers have ap-

peared. Wehrbein (1940) reported a case of double kidney and ureter and bilocular bladder in a child, in which, by operation, he removed the diseased half of the kidney with its ureter and cured the bilocular bladder by division of the septum.

Foley (1928) published a case of double kidney and ureter in which, because of an impassable stricture at the bladder in the hydroureter of the upper kidney, he did a side-to-side ureteral anastomosis below the pelves and obtained a cure, (unconfirmed by pyelograms). He states that he knows of no other case or experiments of this type.

Horseshoe Kidney. In 1926, Colston and Scott stated that Vesalius and the older anatomists had already recognized the condition of horseshoe kidney in the course of dissections and autopsies. Martinow (1910) was apparently the first to divide the isthmus of a horseshoe kidney. Judd, Braasch and Scholl (1922) were apparently the first in America to divide the isthmus in order to rotate the diseased kidney and permit the ureter to lie in the normal position. Gutierrez (1934) presented a monograph on the clinical management of horseshoe kidney. He originated the term "horseshoe kidney disease" to distinguish cases of the anomaly not associated with significant pathological change from cases in which concomitant disease of the malformed kidney was present. Foley (1940) presented a complete survey of the literature and the late results of division of the isthmus and nephropexy in six personal cases. In Foley's cases, the kidneys were approached through an extraperitoneal lumbar incision. The operation was undertaken with the relief of pain as its chief objective and was followed by no mortality. He concluded that the anomaly in itself may be productive of pain and other symptoms which could be relieved by the division of the renal isthmus and nephropexy on one or both sides, to restore the normal anatomical relations.

Renal Ectopia. Augustus Harris (1939) presented three cases of renal ectopia and

brought the entire subject of renal anomalies up to date.

Polycystic Kidney. This is a congenital condition whose development and pathogenesis are still unsolved. The development of pyelography and ureteral catheterization has done much to clarify and simplify the diagnosis. Operation has been considered contraindicated unless complicating conditions such as stone, etc., occur. Nephrectomy is almost never justifiable. Surgical puncture of the cysts or the marsellement of Røvsing (1911) is the most important suggestion that has been made for surgical relief. Goldstein (1935) presented an exhaustive article on the subject and advised "A New Surgical Procedure for Treatment of Polycystic Kidneys," in which a temporary nephrocutaneous fistulous tract is established in a nephrostomized, immobilized kidney. This permitted subsequent puncture of the cysts.

Anomalies of the Ureter. Anomalies of the course of the ureter include those in which the ureter is looped over a fascial band or anomalous artery leading to the lower pole of the kidney, and those in which the ureter pursues a devious course, such as winding itself around the vena cava or aorta, but the latter are relatively rare (Harrill, 1940). These abnormalities cause varying degrees of hydronephrosis and accompanying pathologic conditions which in many cases require operative intervention. Jewett (1940) proved the causal relationship between anomalies and hydronephrosis.

Anomalies of the ureteral orifice include stricture which, according to Chwalla (1925) may often be due to an embryological membrane between the lumen of the ureter and that of the vesicle, which usually disappears early in fetal life but which may remain to form the basis for the ureteroceles.

Caulk (1932) described congenital megaloureter which he said was related to Hirschsprung's disease.

In 1935, on the basis of experimental work done by Sharpe (1906) and Gilbride

(1911), Higgins performed a retroperitoneal anastomosis of a dilated right ureter into the normal left ureter because of intractable, painful, ureteral reflux. This operation had been planned on the basis of cystoscopic and pyelographic findings.

CERTAIN ANOMALIES OF THE LOWER URINARY TRACT

Epispadias. Epispadias was first subjected to operation by Thiersch (1869). His procedure considered in forming a tube from the skin along the dorsum of the penis and approximating the cut edges of the skin on each side. Marked improvement was made by Cantwell (1895) who demonstrated that the method of Thiersch simply produced a urethra on the dorsum of the penis. He proposed separating the corpora cavernosa and burying the tube of detached skin from which a urethra was made behind them and closing the corpora together in front of them. Cantwell's method was reported to be a failure by various operators because, from the lack of proper blood supply, the skin flaps from which the urethra was made sloughed. Young, in 1918, presented an operation for epispadias in which the dorsal skin from which the urethral tube was to be made was left attached to the left corpus cavernosum which was then rotated as the tube was buried beneath the two corpora cavernosa with stitches which drew them together, and then approximated the dorsal skin above them. This operation also comprised a special plastic on the glandular portion to place the urethra in its proper position. The results obtained were satisfactory.

For epispadias with incontinence, Young (1922) presented a much more extensive operation which, in addition to the technic described above, included opening the bladder, excising the redundant mucous membrane of the greatly dilated vesical neck and urethra, and restoring the muscles of the external sphincter, prostate and vesical neck by approximation with continuous sutures of catgut. As a result of this procedure, not only was an almost

normal penis produced, but complete urinary control and normal interval urination were obtained. By practically the same technic, Young was also able to cure epispadias with incontinence in the female (1926).

Exstrophy of the Bladder. This is a much more extensive deformity also associated with epispadias. The open bladder, herniated upon the surface of the abdomen between the widely separated symphysis pubis and divergent recti muscles, presents a much more serious problem. By a technic similar to that employed in the cure of epispadias with incontinence, the bladder was easily restored to its normal position and shape, and the sphincter and urethral plastic procedure easily carried out. Owing to the large defect between the recti muscles, the result in the first two cases was a failure owing to a breakdown of the bladder sutures and the herniation of the vesical mass. Young then dissected a large flap of abdominal fascia, covered the great defect between the recti muscles with it, and held it in place by sutures to the walls of the great opening. By transplantation of the skin the fascial transplant was covered externally. These two plastic procedures cured the exstrophy and gave a fairly normal penile urethra, but owing to a breakdown at the junction of the bladder and urethra, fistulae resulted which as yet have not been cured by operation. The hope of curing this most terrible defect still remains to be fully accomplished. The principles and technic which should eventually lead to success apparently have been evolved. It only remains to secure healing per primam. With the use of sulfathiazole before and after operation to combat and prevent suppuration and breakdown of the operative wound, it is possible that complete success in this dreadful deformity may yet be accomplished by the technic just described.

Hypospadias. As noted above, Duplay and Thiersch before 1890 had presented their classic methods for the operative relief of hypospadias. In 1907, Bucknall

presented his technic. In 1911, Ombredanne published his operation. Various uses of pedicle flaps have been suggested by Cabot, Walters, Counseller, and Blair and others.

Bucknall's operation consisted of suturing flaps of the penis down to similar lateral flaps on the scrotum. Later the urethra was dissected from the scrotum by a long flap which is brought down to cover the raw surfaces of the penis. The scrotal wound is then closed by sutures. Churchman, Harvey and others have reported success with Bucknall's operation.

Ombredanne's operation consists of turning up a flap of skin from the penis or in successive stages from the scrotum and penis in the form of a pouch so that there is no possibility of leakage and therefore no diversion of the urinary stream is necessary. By turning up a pouch from the penis the raw surface is covered by a pierced foreskin which has previously been opened out by dissection. Part of the raw surface of the shaft of the penis is covered by lateral flaps. Reed Nesbit (1940) has modified and improved the method.

Arthur Cecil (*Tr. Am. Assoc. G-U Surg.*, 1931) in a classical article says, "Bucknall's operation cannot be done for perineal hypospadias; it cannot be done in cases of bilateral abdominal cryptorchidism where the scrotum is absent. Where a circumcision has been done previously, the Ombredanne technique cannot be used." Cecil prefers as a rule the technic of Thiersch with overlapping flaps.

In "Genital Abnormalities," etc., Young described various operations which he had used in cases of hypospadias of different types. In a recent paper (1939) he presented a special technic which provided for complete correction of the congenital chordee by excision of the fibrous bands, shortening the suspensory ligament, and incising the redundant foreskin and scrotal skin in extensive cases. Several months later, at the second operation, the penis having been completely relieved of the chordee, a new urethra is provided from

the urinary meatus out to the glands. Suppuration is prevented by giving the patient sulfathiazole for two days before the operation and continuing the drug until after healing is complete (1940).

Hermaphroditism. Operations on pseudo and true hermaphrodites, or to relieve deformities, cure hypospadias, remove enlarged clitoris, and/or bring down concealed vaginae, as well as to remove adrenal hyperplasia, have been described by Broster, O'Farrell, Creevy, Young and by Novak, but lack of space prevents a discussion of this literature.

Hypospadias is so frequently associated with hermaphroditism that it will be necessary to discuss this subject, even though briefly, at this point. In true hermaphroditism the phallus is masculine in type; and if it is decided to remove the female organs, operations to form a urethra in the hypospadiac phallus are necessary. In true hermaphrodites in which the female characteristics predominate and the male are removed at operation, the phallus is amputated. In pseudohermaphrodites of the male type, operations to provide a urethra for the hypospadiac phallus are necessary. Pseudohermaphrodites of the female type present much more complicated problems. The phallus is often just as large or even larger than the normal penis of the same age. The vagina is often absent, undescended, opening into the urogenital sinus at the point where the urethra enters it. Laparotomy shows, as a rule, infantile uterus, small ovaries, and the presence of a prostate. All these conditions are the result of marked hyperplasia of the adrenals, which are usually many times larger than normal due to the great increase in the androgenic zone which lies between the cortex and medulla. A full discussion of this subject is to be found in Young's "Genital Abnormalities, Hermaphroditism, and Related Adrenal Diseases," and can only be referred to briefly here. The surgical operations necessitated are to amputate the clitoris, bring down the vagina to the perineum, and

carry out adrenalectomy on one side, or partial on both adrenals.

Adrenal Operations: The successful operative attack upon diseases of the adrenal cortex is of recent date. The first report of a successful operation upon an adrenal tumor was that of Gordon Holmes (1924) but operations on cases of adrenal hyperplasia are more recent. Among these may be mentioned papers by Crile, Goldzieher and Koster, Broster and Vines, Walters, Cahill and others. Crile exposed the adrenal through an incision along the lumbar muscles, or by a modified kidney incision, in 1932. Goldzieher and Koster (1935) said that both adrenals should be inspected to avoid overlooking adenoma, single or multiple. They used the extra-peritoneal approach through an oblique incision of the muscles and exposed first one side and then the other. Broster (1933) reported using a transthoracic route after rib resection. Cahill (1936) said that he used an incision from the ensiform downward and outward along the costal border, palpated both adrenals and removed the one that was found to be the site of a tumor. Walters (1935) used an oblique lumbar incision such as is employed in exposing the kidney. The peritoneal cavity was opened, the pelvis and opposite adrenal examined. In 1936, Young reported using a simultaneous bilateral exposure of the adrenals with the patient lying upon his chest, through incisions along the outer borders of the spinal muscles, which were compressed by a special self-retaining retractor, thus allowing simultaneous inspection of both adrenals and the removal of one that was involved in hyperplasia. Additional cases were reported by Young in 1937. Remarkable results, with cure of virilism, have been reported by many of the operators.

Cahill (1935) found perirenal air injection, which had been introduced by Carelli in 1921, of much value in determining the presence of adrenal tumor.

Cryptorchidism. Since 1756, when John Hunter urged that nature should be assisted in every possible way to bring down

a testicle which failed to descend into the scrotum, the subject has excited great interest. It has long been known that the testicle that remained in the abdomen or even in the inguinal canal failed to develop spermatogenesis and often remained very atrophic. The most important work in recent years has been that of Carl Moore (1930) who in a beautiful series of animal experiments showed that it was probably the greater heat in the groin and peritoneal cavity which was responsible for the failure of testes to go on to spermatogenesis. Recent and more extensive experience with hormonal injections has added much to our knowledge of the descensus of the testicle, as will be pointed out later on.

Innumerable procedures for cryptorchidism have been proposed, as shown in the following extensive compilation from foreign sources published by Hinman (1935):

A. Orchiopexy

- i. Extirpation of the processus vaginalis without orchiopexy—Sergi-Trombetta, 1897.
- ii. Fixation of testicle in the fundus of the scrotum (after freeing the spermatic vessels and vas of bands, peritoneal attachments, adhesions, etc. (LaRoque, 1931)).
 - a. Original method—Rosenmerkel, 1820; Chelius, 1821; Anandale, 1879.
 - b. Separation and division of the tunica vaginalis with broad fixation of the testicle in the base of the scrotum—Schüller, 1881; Nicoladoni, Czerny, Koerte.
 - c. Purse-string suture at the neck of the scrotum near the root of the penis—Kocher, 1887; Bevan, 1899, 1903; J. Wolff, 1901.
 - d. Temporary transplantation of the testicle outside the scrotum—Hahn, 1888.
 - e. Excision of the cremaster—Felizet, 1891.

- f. Fixation after herniolaparotomy—Kocher, Buedinger.
 - III. Fixation in the scrotum with perineal flap covering—Hermes, 1904.
 - IV. Traction method
 - a. Traction by thread or elastic with attachment:
 1. To wire frame—Bidwell, 1893; Lanz, 1905.
 2. To thigh—Longard, 1903; Lanz, 1905.
 3. To heel—Tomaschewsky.
 4. By a stiff buried wire within the scrotum—Starr, 1908.
 5. Fixation of the scrotum to the perineum—Delbet, 1906.
 - b. By operative fixation to the thigh:
 1. Skin, fascia lata pedicle flap, later transplanted—Katzenstein, 1902; Odiorne and Simmons.
 2. Fixation to the thigh with later separation:
 - (a) Fixation suture only—Anandale, 1901; von Bramann, 1907.
 - (b) With transplantation of the testicle—Keetley, 1894; Gelbke, 1905; de Beule, 1905; Torek, 1909 (not with traction principle, 1931).
 - v. Perineal fixation:
 - a. Nicoladoni, 1895.
 - b. With use of free transplant of fascia lata—Kirschner, 1910; Muehsam, 1911.
 - VI. Subcutaneous fixation by suture:
 - a. To the pubic bone—Bayer, 1896; Helferich, 1899; Heinelein, 1900; Gersuny, 1905; Delbet, 1906; Zwanziger.
 - b. To scrotal tissue—Kirmisson, 1901; Cudray.
 - c. To the interscrotal septum—Tuffier, Championnière, Sébilleau.
 - VII. Transplantation with the scrotum into the opposite scrotal sac, or by fixation to the opposite testicle—Walter, Gersuny, 1905; Witzel, 1905; Schaefer.
 - VIII. Transplantation or burial of spermatic cord:
 - a. Suture in the inguinal canal only—Broca, 1899; Ruff, 1904; Mignon, Auvray.
 - b. Similar with purse-string suture at the scrotal neck—Bevan, 1899; Kocher, Rieffel, Delagénier, Negron.
 - c. Similar with plastic operation at external ring—C. Beck, 1905.
 - d. Similar with formation of canal in scrotum—Lotheissen, 1905; Czerny.
 - e. From iliac brim to external abdominal ring—Davison.
 - IX. Division of spermatic vessels, if necessary—Bevan, 1903, 1904 (Riedel, Anschütz, Küttner, Moschkowitz, Czyzewski).
 - X. Displacement of the spermatic cord beneath the epigastric vessels—Frangenheim, 1920.
 - XI. Placing of the spermatic cord through the obturator foramen (performed on cadavers only), Sievers, 1920.
 - XII. Division of the spermatic cord—Murray, 1913 (Philipowicz).
 - XIII. Extension of the genital canal—Pólya, 1921 (Bonem).
 - XIV. Preperitoneal displacement—Rizzoli, 1885 (Schönholzer, Exalto, Brenner).
- B. Transplantation in the peritoneal cavity:
- I. Abdominal: Rotter, Dardel, Steinmann, Spitzzy, Corner, Gohrbandt, Brenner.
 - II. Intraperitoneal: Brenner.

C. Semicastration: Seemann, Szymanowski, Kocher, Kopyloff, Küster, Paschen, et al.

As will be seen in the above tabulation of ingenious procedures that have been employed by scores of operators to bring the testicle to its proper place in the scrotum, several of the technics described by modern surgeons were used many years ago.

Among the methods widely employed is that usually known as the Bevan operation, but apparently presented first by Kocher in 1887. Bevan showed the importance of liberating the fibrous adhesions by freeing the testicle and cord from attachments to the peritoneum and the hernial sacs, thus lengthening the cord so that the testicle could be carried freely and loosely to the bottom of the scrotum. He stressed the importance of preserving the spermatic vessels and the artery of the vas. Bevan prevented retraction by a purse string at the neck of the scrotum.

Often the testicle is prevented from entering the scrotum by a tight external ring or an abnormal mass of fat. Studies of the literature show that the Bevan operation sometimes failed to hold the testicle well down in the scrotum and occasionally produced atrophy, probably from constriction of the cord. The method of suturing the testicle to the thigh by some of the technics mentioned above is now considerably employed with apparently very satisfactory results.

Denis Browne (1938) advises operation with the testes in the following undescended positions: "Emergent inguinal"—can be felt popping in and out of the external ring; "middle inguinal"—the testis is in a hernial sac; "entrant inguinal"—the testis is between the upper end of the inguinal canal and the abdominal cavity; and "abdominal"; but he questions whether or not one is justified in opening the abdomen. Ectopic testes require operation.

Engle (1932) caused a descent of the testes of an immature Rhesus monkey by the injection of anterior-pituitary-like prin-

ciple. Goldman and Stern (1933) cured two boys with undescended testes by the same method.

Since then innumerable reports of the successful treatment of cryptorchidism by hormonal therapy have appeared in the literature. The hormone is believed to exert its effect by stimulating the interstitial cells which then secrete more male sex hormone. The controversy between those who advocate immediate surgery and those who prefer nonintervention, with or without hormonal injections, is still raging.

In a paper on "The Biological Properties of Male Gonadotropic Hormone," H. H. Cole (1936) showed that in rats receiving very high dosage the tubules of the testis show evidence of damage.

Denis Browne (1938) said, "The testis that can be pushed down over the pubic bone will invariably descend spontaneously by the time full growth is reached. A testicle that is in the inguinal canal cannot be felt through the skin. Hormone treatment will not bring down any testis that would not have descended without it, though it will hurry the descent. Whether this acceleration is worth the risk of certain disquieting possibilities is a matter of opinion."

Eisenstaedt, Appel and Frankel (1940) said, "One must differentiate clinically the testis which will descend when it reaches or approaches adult size and weight from the group of true undescended and ectopic testes, which always require operation. Retractable testes may descend spontaneously as late as the seventeenth year. Gonadotropic substance has no value in the preoperative care of true undescended and ectopic testes, and its use in retractile testes is not recommended." It may be definitely harmful in larger dosage, as they showed by experiments on rats.

The literature, especially papers by European authors, is very voluminous. For an analysis, see "Genital Abnormalities, Hermaphroditism and Related Adrenal Diseases" (Young, 1937).

MALE SEX HORMONES

Many years ago the relationship between the gonads and the sexual impulse was recognized, but only recently has any real advance been made in determining the true nature of the sex hormones and their effects when introduced into the body. Ancel and Bouin (1903) concluded from their studies that the tubular and interstitial portions of the testicle had different functions. These authors called attention to the fact that abdominal retention of the testes may not prevent the development of secondary sex characteristics, but did prevent spermatogenesis. The first attempt to transplant testicular substance in man was made by Hammond and Sutton (1912). The crude extracts injected before 1927 were so impure and of such low potency that the results obtained were insignificant.

In 1927, McGee extracted from human male urine an androgenic substance which repaired the atrophy of accessory sex organs in castrated animals and promoted comb-growth in the capon. Improvements in methods resulted in the extraction of substances which were more and more potent. In 1931, Butenandt extracted from 15,000 liters of human male urine 15 mg. of pure crystals. The following year he suggested its chemical structure, and this was confirmed by Tscherning in 1934. It was called androsterone. In 1934, Ruzicka and his co-workers synthesized androsterone from cholesterol. In 1935, David, Dingemans, Freud, and Laqueur isolated from bulls' testes a potent androgenic substance in crystalline form which they called testosterone. In 1935, Butenandt, Henisch and Ruzicka and their co-workers synthesized testosterone.

Lower and McCullagh (1932) reported results of their experiments which convinced them that the testicle elaborated two hormones: androsten and inhibin. The latter was not isolated but was postulated to be a water-soluble substance formed by the germinal cells which acted as a control on the pituitary. These observations have

not been confirmed by other investigators. A series of cases in which the enlarged prostate was treated by injections of inhibin were published.

Vest (in Young's "Genital Abnormalities," etc.), Bauer and Koch, Hamilton and also Foss reported beneficial results from the injection of testosterone in cases of hypogonadism. Since then, numerous papers have appeared in the literature. Vest and Howard (July, 1938) reported six cases of hypogonadism and two cases of pre-adolescent boys; they concluded that the injection of testosterone propionate was a satisfactory replacement therapy for hypogonadism. Since then, the hormone has been administered successfully in the form of an ointment rubbed into the skin and in tablets which can be taken by mouth. Howard and Vest (1939) were the first to implant pellets of pure testosterone and testosterone propionate beneath the skin. They showed that the absorption was continuous and even, and that the drug was effective for a protracted period of time. Testosterone has not been proved of value in cases other than those of testicular deficiency.

TRAUMATIC LESIONS OF THE URINARY TRACT

Kidney and Ureters. The history of this subject goes back to the time of Hippocrates. Tuffier (1889), Küster (1896) and Albarran (1899) advanced the knowledge of the mechanism and pathology of renal injuries and reported important operations. In 1908 Lardennois published a complete review of the subject and since then numerous papers have appeared. Rolnick (1926) reported that at the Cook County Hospital, Chicago, the incidence of renal injuries had been 1 in 3,000 admissions. The literature is cited by Gutierrez in an extensive article on the subject in Cabot. With modern urologic methods of diagnosis: x-ray, urograms, cystoscopy, etc., much progress has been made in the diagnosis and treatment of traumatism to the kidney, but there is still great variance of

opinion as to treatment. Albarran, Marion and Papin advocated the use of a network of catgut sutures placed around the kidney to hold the fragments in place, a method proposed by Marcille (1908). Since the introduction of ribbon gut by Lowsley (1933) he and others have used it frequently to bind together the ruptured kidney masses. A recent paper on the subject is that of Austin Wood (1937). Ureteral injuries generally are the result of accidents at operation or during cystoscopic manipulation, especially in the extraction of calculi. The use of heavy metal stilets in ureteral catheters is occasionally the cause of serious trauma to the ureter. The first case of successful anastomosis of a ruptured ureter was reported by Kelly (1892), using Van Hook's method of end-to-side invagination. The first successful transverse end-to-end anastomosis was done by Cushing (1893) and by W. Tauffer (1893). The latter used a small piece of catheter to splint the point of anastomosis, removing it before tying the last sutures. A. W. M. Robson (1896) was the first to do successfully an end-in-end anastomosis by the method of Poggi (1887). In 1897, Bovée used an oblique end-to-end anastomosis without support. End-to-end anastomosis with the help of an inlying ureteral catheter was first done by MacArthur (1925).

Bladder. The subject is vast, and cannot be fully dealt with here. Rouvillois and Ferron (1921) presented a survey of the subject. Vaughn and Rudnick (1924) advocated pneumocystography to diagnose ruptured bladder. A recent paper is that of A. R. Stevens and W. R. Delzell (1937).

They report twenty-seven cases, fourteen of intraperitoneal injury with eight deaths, and only two deaths among thirteen patients with extraperitoneal injury alone. They advise exploratory laparotomy, especially in the early cases, and prefer complete suture, if possible. The treatment of shock is most important. Rupture of the bladder during urological examinations occurs only too frequently. Eleven cases of rupture during cystoscopic instrumentation are reported in "Young's Practice of Urology."

Posterior Urethra. These often occur as a result of fracture of the pelvis in which infrequently the prostate is torn from the membranous urethra. This is sometimes associated with rupture of the bladder, and all too often has received little operative relief except suprapubic drainage. Before 1890, no cases were reported of anastomosis of the ruptured posterior urethra. Where, on account of shock, the operator is unable to carry out immediate anastomosis, subsequent operations should include careful exposure of the prostate through the perineum and meticulous anastomosis to the membranous urethra around a retained catheter.

Anterior Urethra. Before 1890, operative treatment of these conditions was well systematized and no great technical advance has been made since then.

I cannot close this long but still incomplete review of "Fifty Years Progress in Urology" without expressing my sincere thanks to Hugh J. Jewett, Balcom Moore, Lloyd G. Lewis, James Semans, Richard W. Satterthwaite, Justina Hill, Bertha Trott and William Guerin.



ADVANCES IN NEUROLOGICAL SURGERY DURING THE PAST FIFTY YEARS

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A COMPLETE account of the accomplishments that have made possible the rapid advances in the surgical treatment of diseases of the nervous system during the past fifty years would encompass the contributions of investigators working in practically every field of medical science. Even to trace in detail the evolution of any particular operative procedure, would necessitate an exhaustive study of all accumulated knowledge pertaining to that therapeutic measure, an undertaking far beyond the scope of the present review. In collecting the data for this historical sketch many valuable papers have no doubt been passed over, while the concepts derived from others may have been accorded undue prominence. This is especially true of numerous ideas incorporated in papers appearing during the past decade, since some of these ideas have not been given sufficient trial for proper evaluation. A great mass of information, particularly that pertaining to anatomy and pathology, had accumulated during the eighteenth and nineteenth centuries and by 1890 the importance of its clinical applicability had become quite generally recognized.

The latter half of the nineteenth century was marked by many notable contributions that directly influenced the inception of neurological surgery. To mention but a few: Helmholtz had introduced the ophthalmoscope; von Graefe, and Hughlings Jackson had published papers concerning optic neuritis; Broca had furnished the first precise proof of cerebral localization when he demonstrated the lesion in the brain of a man who for twenty-one years had lost the faculty of speech; Fritsch and Hitzig had identified certain centers in the animal

brain by means of electrical stimulation; Pasteur had established the microbic origin of disease; Virchow had brought pathological study to a high state of perfection; Lister had introduced the method of antiseptic surgery; Morton, and Simpson had demonstrated the feasibility of general anesthesia during surgical operations; Ferrier had recreated the science of experimental neurology; and Charcot, Gowers, Jackson, Marie, Duchenne, and others had correlated some of the knowledge gained in the laboratory with detailed clinicopathological studies. The work of these and others set the stage for advancements in therapy. It is, therefore, not surprising that at this time surgeons became interested in performing operations on the nervous system previously not attempted. Between 1879 and 1889 the reports of Macewen, Godlee, Durante, Horsley, von Bergmann, Keen, and Wagner indicated an active interest in this new field of surgical endeavor.

During the fifty years under consideration in the present review (1890 to 1940) it is the writer's opinion that there have been, at least in America, four major influences in the development of neurological surgery: (1) the discovery of the roentgen ray by Wilhelm Conrad Roentgen (1895); (2) the numerous technical devices introduced and the clinicopathological entities elaborated upon by Harvey Cushing during a long and fruitful career (1901 to 1939); (3) the revolutionary method of identifying and localizing brain lesions by means of cerebral aerography instituted by Walter Dandy (1918), and (4) the histological classification of the cerebral gliomas by Percival Bailey and their clinical correlation by Cushing (1925). In addition to these

monumental works a host of contributions of lesser import have furthered the evolution of neurological surgery as practised today.

EXPERIMENTAL, DIAGNOSTIC AND TECHNICAL ADVANCES

Clinical neurology stands today as it did fifty years ago, the vanguard of neurological surgery. The names of Rolando, Goll, Flourens, Bouillard, Bright, Dalton, Ferrier, Flechig, Monk, Frank, Gudden, Henschen, Monakow, Fritsch, Hitzig, Turck, Gaskell, Luciani, and Galtz are a few of the many noteworthy contributors who laid the very foundation stones for further progress. Near the turn of the nineteenth century several important studies were conducted in the laboratory of Sherrington, in particular his analysis of the segmental reflex mechanisms (1896 to 1906), the elucidation of the significance of the decerebrate posture (1897 and 1898) and the careful study of the motor area in the anthropoid ape (1901 to 1903), deserve attention. Precise identification of the visual cortex resulted from the work of Schäfer (1888), Henschen (1890), Minkowski (1911), and Holmes (1918). Cushing and his associates reported on the distortion of the visual fields in a series of six papers, the last of which appeared in 1922. The development of a new branch of neuroanatomy, architectonics, by Brodmann, Campbell, and by Vogt (1903 to 1905) was made possible by the utilization of the new impregnation methods (Cajal) for histological study. The studies of Ramon y Cajal and his pupils stand as the most important advance in the clarification of the histology of the nervous system. In 1889, von Bergmann published a book in which operations for brain abscess, brain tumor, epilepsy and other neurological disorders were described. Charles Dana's "Textbook of Nervous Diseases" appeared in 1892 and in 1893, M. Allen Starr completed a volume on brain surgery, devoting chapters to cerebral palsies in childhood, epilepsy, trauma, abscess of the brain and

brain tumors (including a tabulation of six hundred nonoperated cases of brain tumor, three hundred of which were in children). By 1910, several comprehensive monographs had appeared on the subject of brain tumor, Oppenheim's "Die Geschwülste des Gehirns" (1896), Duret's "Les Tumeurs de l'Encephale" (1905) and Bruns' "Die Geschwülste des Nervensystems" (1908).

Another important step in the advance of the localization of cerebral function was ushered in by the experimental studies on the hypothalamus, begun in 1909 by Karplus and Kreidl. Camus and Roussy extended this work and reported on the results of experimental lesions at the base of the brain (1913 and 1914). About this time work on the pituitary body was given impetus by the excision of this gland in the dog by Cushing with the production of the adiposogenital syndrome and the criticism of his work by Aschner (1912) who suggested that injury to the base of the brain might account for some of the experimental results. It is true that the foundations for their work were laid earlier by Minkowski (1887) who was the first to suggest the causal relationship between the hypophyseal gland and acromegaly. Marie, in 1884, clearly described the clinical syndrome of acromegaly. The classical case report of Fröhlich (1901) drew attention to the fact that all pituitary tumors were not associated with acromegaly. There followed a period of confusion of the interpretations of the symptoms and signs of hypothalamic lesions with those of pituitary origin.

During the second decade of the present century several new syndromes pertaining to clinical neurology were described: the syndrome of the foramen lacerum posterius, Vernet (1916), the syndrome of the retro-parotid space, Villaret (1918), and Wilson's disease, described in 1912. In 1915, Jelliffe and White published a treatise on diseases of the nervous system. Holmes contributed greatly to our knowledge of the physiology of the cerebellum. In 1911, Head and Holmes and in 1918 Holmes reported on

the nature of the cortical sensory processes in man. Investigation concerning the extrapyramidal motor system was published by the Vogts in 1919, later by Adie and Critchley (1927), Fulton and his associates (1932 and 1933), and by Richter and Hines (1932). In 1921, appeared the classical paper of Bailey and Bremer on diabetes insipidus. The syndrome of gigantism was given a sure footing by the publication of Evans and Long in the same year. Then in 1929 Putnam, Benedict and Teel reported the production of acromegaly in the dog, comparable to that seen in man, following the repeated injection of an alkaline anterior lobe pituitary extract. Penfield described sympathetic epilepsy in 1929. Cushing (1932) reported on the reaction produced by drugs injected into the lateral cerebral ventricles. The control of autonomic functions by the cerebral cortex was being investigated by Beattie, Brow and Long (1930). The importance of the hypothalamus in heat regulation was demonstrated by Keller and Hare (1932). Davis, Cleveland and Ingram (1935) protected the pancreatic animal against diabetes by a properly placed hypothalamic lesion. The report of Tower and Hines (1935) aided in the clarification of the pyramidal syndrome.

Many other contributions, both clinical and experimental, that have advanced our knowledge concerning the localization of lesions of the nervous system might rightfully have been included here. These have been reviewed and critically analyzed in several important books devoted to disease of the nervous system. Among these may be mentioned: Brain and Strauss' "Recent Advances in Neurology" (1929), Wechsler's "Textbook of Clinical Neurology" (1929), S. A. Kinnier Wilson on "Modern Problems in Neurology" (1929), "The Basis of Clinical Neurology" by Brock (1937), and "Physiology of the Nervous System" by Fulton (1938).

Quinke is credited with the introduction of the method of lumbar puncture in 1891. There followed a description of a syndrome by Froin in 1903 which now rightfully bears

his name; the double spinal puncture of Marie, Foix and Robert (1913); in 1916 a test to determine the patency of the spinal subarachnoid space by Queckenstedt; and in 1920 cisternal puncture by Ayer. Important studies of the cerebrospinal fluid were carried out, cytological (Widal, Sicard, Ravaut, 1900 to 1901); serological (Levaditi and Marie, 1906; Plaut, 1909); chemical (Mestrezat, 1911, 1912; Lange, 1912); biological (Kafka, 1911 to 1930), and recently a critical analysis of the present-day knowledge concerning this fluid (Merritt and Fremont-Smith, 1937). In 1921, Sicard advocated spinal subarachnoid injection of lipidol for the roentgenographic localization of intraspinal tumors. Dandy (1919) had preceded this with the prediction that air would come to be used as a diagnostic measure for intraspinal lesions and in 1922 first reported on this method.

Ventricular puncture was used as a therapeutic measure long before it became a diagnostic procedure. It is said that Dean Swift was treated for hydrocephalus by this method. Ventricular drainage was suggested by Wernicke in 1881, by Zenner in 1886 and by Keen in 1888. Von Bergmann tapped the ventricle of a patient with brain tumor in July 1887. In this country Keen was probably the first to utilize this method (January 11, 1889). Cushing is credited with the popularization of the procedure during operations on the brain (in 1906 he advocated leaving a lumbar puncture needle in position for the reduction of pressure during the course of operation on the cerebrum but later substituted ventricular drainage for this purpose). In 1904 Neisser and Pollack described a method of brain puncture to obtain tissue for histological study but this means of diagnosis has never gained wide-spread usage in the United States. In 1895, Roentgen, while experimenting with a Crookes tube, realized the unusual ability of the rays to penetrate the body and thus paved the way for the use of the ray which now bears his name. The Coolidge tube and the Potter-Bucky diaphragm (both introduced in

1913) improved the quality of roentgenography. In 1918, Dandy described the method for demonstrating the size and position of the cerebral ventricle by roentgen ray examination following replacement of ventricular fluid with air. At this time the procedure had been carried out in twenty children to diagnostic advantage. It was pointed out that in an analysis of one hundred cases of brain tumor by Heuer and Dandy in 1916, only 6 per cent of the tumors cast shadows on the roentgen ray films. Dandy stated that his studies on ventriculography were suggested by the oft repeated comment of Halsted on the remarkable power of intestinal gas "to perforate bone" as visualized on the roentgen ray film. In 1919, he reported on the roentgenography of the brain following injection of air into the spinal canal. Subsequently (1920) he published an article on the use of ventriculography as applied to adults. Naffziger (1925) indicated that the position of a calcified pineal body as shown on the roentgen ray films aided in determining the location of a space-occupying lesion within the cranial cavity. In 1922, Dandy described the use of a ventriculoscope (at first a small cystoscope was employed and later a specially designed ventriculoscope) which was utilized for visualization of the lateral ventricles, and when indicated, for fulguration of the choroid plexus. In 1929, Hans Berger reviewed the accumulated knowledge relative to "brain waves" and reported on his investigations in this field. This type of examination was designated electroencephalography and is now being widely employed; however, its ultimate importance in clinical diagnosis awaits further investigation. Moniz, Pinto and Lima described a diagnostic procedure in 1936 calculated to provide a differential diagnosis between meningiomas and other cerebral tumors by the use of a radioopaque material injected into the previously exposed internal carotid artery. The method has not been generally used in America except for demonstrating lesions

implicating the blood vessels of the intracranial cavity. The work of Bailey (1926) on the histological classification of tumors of the glioma group may properly be mentioned under the section dealing with brain tumors. The investigations, however, seem to deserve inclusion here since the verification of the histological nature of a tumor when exposed at operation is of inestimable importance and frequently influences the extent of the surgical procedure to be performed.

With the advent of cerebral surgery it was noted that following an unsuccessful attempt to remove a cerebral neoplasm the patient was often relieved of "the classical symptoms" of brain tumor, at least for a period. Robert F. Weir is cited by Cushing (1909) as being the first to suggest the possibility that a cranial exploration might afford relief though no tumor be found. Sir Victor Horsley (1890 and 1893) was the first to advance the idea of a premeditated craniectomy for the relief of the more distressing symptoms of brain tumor, especially the preservation of vision, regression of papilledema and relief of headache. Jaboulay coined the term "trepanation decompressive" in 1896 from these palliative operations and apparently they were performed in any area of the cranium elected by the surgeon. Sanger later advised the positioning of the craniectomy over a relatively "silent" area of the brain.

Cushing published his method of "intermusculotemporal procedure" in 1905. Selecting a "silent" area protected by muscle, he removed a 6 by 8 cm. piece of bone beneath the right temporal muscle, the forerunner of the now classical subtemporal decompression. Among contemporary surgeons there was a reluctance to open the dura for the purpose of decreasing pressure. Sanger advocated ventricular puncture and Broca and Maubrac lumbar puncture to reduce the intracranial tension. Cushing advised against this latter procedure in cases of brain tumor, except to measure pressure, and mentioned a fatality following removal of about 10 cc. of cere-

brospinal fluid by the lumbar route. Methods of repairing cranial defects were already being considered although it is true that many surgeons thought the restoration of the cranial contour of little importance and boldly sacrificed large areas of bone in exposing the brain. Cushing also described the suboccipital decompression which was not unlike that used today except that the posterior collar of the foramen magnum was not usually removed; however, the cross-bow incision was made, with division of the posterior cervical muscles in the midline. Frazier advocated division of the occipital sinus as an aid in the exposure of the cerebellar hemisphere.

In a subsequent paper by Cushing (1908) certain refinements were described: shaving the scalp on the day of operation; placing the patient on the table before inducing anesthesia; the recommendation that ether be used; records of blood pressure and pulse plotted during operation; preparation of the scalp with alcohol and bichloride; scratching the skin to mark the site for incision; bichloride gauze over the operative field; head rest for occipital work; pinning sheets to the scalp, etc. Advances in the osteoplastic flap operation were recorded: Wagner was the first to expose the brain by this method; Toison suggested the use of a chain-saw for cutting the bone flap; Obalinski recommended the use of the saw devised by Gigli for obstetrical purposes; Stellwagen designed a curved saw operating about a fixed point; Cryer, Sudeck and Sykes each described motor driven saws; Doyen used a motor with a flexible handle, and Borchardt, Barcut and Hartley each devised motor-driven cutting tools. The Galt conical saw was in popular use as the instrument of choice in making the primary cranial opening. Hartley and Kenyon advised breaking the flap with the temporal bone as a base, for this site was thin and muscle provided good nourishment for the flap. Cushing made a beveled flap with the aid of a Gigli saw and employed a grooved director in opening the

dura. Round-pointed, fine, cambric needles were suggested for approximating the edges of the scalp. He advised against decompression operations over vascular tumors since this might result in intratumorous hemorrhage. A second paper by Cushing published in the same year deals with the use of the subtemporal decompression in the treatment of extradural and subdural hematomas and other complications resulting from trauma of the head.

In another paper Cushing (1909) described a spoon spatula for retracting the brain while exploring beyond the bony margins. The report presents the idea of combining a decompression opening with an osteoplastic flap. In addition to these features there are also mentioned, probably for the first time: clamping of the galea and reflecting it over the cut edge of the scalp rather than an attempt to clamp the divided blood vessels individually; the use of cotton pledgets instead of gauze for intracranial work; the use of minute Mikulicz pads; striated muscle as an aid to hemostasis; silver clips for hemostasis; careful separate closure of the galea aponeurotica by interrupted, fine, black, silk sutures; and the plotting of ether tension during the operation (Boothby, 1913).

In 1920, Cushing described the straight incision for subtemporal decompression as now employed stating that the curved one interfered with the cutting of an osteoplastic flap should this type of operation subsequently be indicated. Other noteworthy improvements were: gray sheets for final draping of the patient; control of hemorrhage by digital pressure while applying clamps to the galea; ventricular puncture to lessen tension and also as an aid in diagnosis in certain cases; use of headlight in a semidark room, etc. These and other technical details advocated by him have assumed considerable importance since the so-called Cushing ritual has so greatly influenced progress in neurological surgery in America.

BRAIN TUMORS

To Godlee goes the credit of being the first to operate on a clinically localized neoplasm of the brain. Bennett advocated the operation and on November 25, 1884, Godlee removed a walnut-sized, hard, glioma, lying one-fourth of an inch below the cerebral cortex, through a one inch incision in the ascending frontal convolution, avoiding the cortical blood vessels. Hemorrhage was arrested by the use of a galvanocautery and the "wound brought together with sutures." By the middle of the ensuing month the patient had recovered from the operation but a cerebral fungus was present and the paresis in the opposite lower extremity had increased. Shortly thereafter the patient died. About six months after the heroic effort of Godlee, Durante successfully removed a brain tumor. Requiring but an hour for the operation, on June 1, 1885, he opened the frontal bone and scooped out a meningioma, packing the nasal cavity with gauze (the cribriform plate had been eroded). For several years the patient remained symptom-free but finally succumbed following an attempted removal of a recurrence of the tumor some twelve years after the original operation. Keen (1888) reported the successful removal of a convexity meningioma and by the turn of the century the literature was replete with the description of surgical procedures carried out on various types of intracranial tumors.

The syndromes produced by the pituitary adenomas received rather critical attention. Horsley was an early worker on this gland but Cushing was the prime mover behind the clinical advances in this field. Caton and Paul (1893) acting on Horsley's suggestion were the first to attempt an exposure of the hypophysis utilizing a lateral subtemporal opening, however, the operation was terminated without exposing the pituitary. Intracranial procedures of a radical nature for the exposure of the pituitary body were proposed by Horsley (1904) and by Krause

(1905), the chiasmal area to be visualized by elevating a frontal lobe of the brain. It appears that Borchardt (1907) was the first to put this suggestion into practice. In 1907 Schloffer performed the first fairly successful operation on a tumor of the hypophysis approaching the area by the transnasal route. Kanavel (1909) modified the intranasal procedure and the next year Halstead, and Hirsch added other technical variations to the operation. To Cushing belongs the credit for perfecting the intranasal operation which came to be known as the transphenoidal route for exposure of the pituitary gland. The technique was described by him in his 1912 monograph, "The Pituitary Body and its Disorders." The transphenoidal operation gained in favor and was used by Cushing in particular. The presence of suprasellar extension of pituitary tumors, approachable only by the subtemporal or transfrontal route seems to have encouraged the more frequent use of the intracranial operation. Eventually, the exposure of the chiasmal region by a frontal bone flap and elevation of the frontal lobe became almost universally adopted as the procedure of choice not only for tumors of the pituitary gland but for other neoplasms encountered in this region.

The acoustic neuromas form another chapter in the history of neurological surgery which illustrates the remarkable reduction in mortality that has come about through a better understanding of pathology coupled with newer technical advances. Although these neoplasms were among the first to be attacked surgically, their inaccessibility led to a high percentage of failures. In 1913, Tooth reported a 58 per cent mortality in twelve cases; twelve of von Eiselsberg's sixteen cases ended fatally and Krause had thirty-one patients of whom twenty-six died. Cushing's monograph on the subject appeared in 1917 and the recorded mortality of 20 per cent indicated the improvement that he had made in the diagnosis and treatment of these tumors. Details of the cross-

bow incision and removal of the posterior collar of the foramen magnum were presented, a distinct improvement over the previous approaches which were often made without adequate exposure. In 1922, Dandy proposed a method for the total extirpation of these tumors (heretofore the operation had consisted of intracapsular removal) and in 1932 he advocated that they be removed through a unilateral approach. Horrax (1938) advised amputation of the lateral one-third of the cerebellar hemisphere on the involved side, complete removal of the tumor and a thorough cleaning out of the internal auditory meatus.

In 1922, Dandy, in an article entitled the "Treatment of Non-encapsulated Brain Tumors by Extensive Resection of Contiguous Brain Tissue," advanced the idea of premeditated lobectomies as an aid to the prevention of recurrence of malignant brain tumors or at least an effort to deal with these in a radical manner. In a subsequent paper, published in 1925 he advocated the deliberate removal of lobes of the brain, when feasible, to afford adequate visualization to certain deep-seated lesions and to lessen the trauma incidental to their removal. In this article the use of concealed scalp incisions were recommended. In 1928, he extended the idea of lobectomy and advised right hemispherectomies for malignant lesions of the right cerebral hemisphere when it appeared that function of the opposite side of the body had been permanently lost by the destructive action of the tumor or if such a radical procedure offered some hope of cure.

Out of chaos came some order concerning the large group of gliomas when in 1926 Bailey and Cushing published their monograph on this subject. One of the important facts clarified by this study was that about 40 per cent of the classified gliomas represented fairly benign lesions. Although considerable knowledge has accumulated concerning the life history and the pathology of the malignant gliomas, up to the present little progress has been made in the treat-

ment of these tumors. It is becoming increasingly evident that unnecessary surgical mutilation only adds to the incapacitation of the patient and does not lengthen his life. Roentgen ray therapy has likewise proved discouraging in the treatment of these lesions. Two years after the appearance of the above monograph another was published by Bailey and Cushing on tumors arising from the blood vessels. Perhaps the most important advance made here was the recognition of the benign character of the hemangioblastomas which present a favorable outcome second to no other neoplasm encountered within the cranial cavity. The monograph of Dandy, "Benign Tumors in the Third Ventricle of the Brain: Their Diagnosis and Treatment," which appeared in 1933 and a second monograph by the same author in 1934, "Benign, Encapsulated Tumors in the Lateral Ventricles of the Brain: Diagnosis and Treatment," have established methods for the successful management of these lesions.

The advances made in the therapy of meningiomas encompass the delineation of the following syndromes: (1) meningiomas of the olfactory groove (Cushing 1927) (Durante's case operated in 1885 was of this sort); (2) suprasellar meningiomas (Cushing 1903); (3) meningiomas of the sheath of Schwalbe (Cushing 1937). Cushing and Eisenhardt's recent publication, (1938) "Meningiomas," gives an excellent account of the advances made in the diagnosis and treatment of these tumors. Although a benign lesion, they often presented a special problem in the control of hemorrhage and it was not until the introduction of the suction apparatus and the electrocoagulating unit (Cushing and Bovie 1928) that the surgeon had at his command technical methods by which the field of operation could be kept reasonably dry. Although the diagnosis and treatment of many types of tumors encountered in the intracranial cavity have been brought to a high state of perfection, there still remains a large group of malignant gliomas for

which no curative surgical measure is as yet available.

SPINAL CORD TUMORS

It was in 1823 that Sir Astley Cooper made the far-seeing statement, "Though I may not live long enough to see the operation (referring to laminectomy for treatment of injuries to the spine) frequently performed, I have no doubt that it will be occasionally performed with success." To this statement, Sir Charles Bell responded, "We must submit to hear many strange proposals for the improvement of our profession in the present day from young men ambitious of notice, but that a man of Sir Astley's years and station should talk as he has done before students and given them his authority for laying a patient upon his belly and by incisions laying bare the bones of his spine, breaking up these bones and exposing the spinal marrow itself, exceeds all belief."

Something was known regarding the functions of the spinal cord as long ago as the early part of the Christian era, for in that time Aretaeus recognized that the paralysis produced by pressure on the cord may at times be homolateral. Apparently, Morgagni in 1769 was the first to speak of compression of the spinal cord by tumor. Horsley was the first to remove a spinal cord tumor (June 8, 1887, a little more than two years after Durante first successfully removed a brain tumor). The patient was a forty-two year old male, paraplegic and incontinent, with loss of cutaneous sensation below the level of the fifth dorsal dermatome and suffering severe pain. Horsley exposed and removed an intradural fibromyxoma attached at its lowest portion to the highest root of the fourth thoracic spinal nerve on the left. A year later the patient was well, walking about and free of pain. Interest in spinal cord tumors was extended and the names of Horsley, Frazier, Krause and Elsberg are outstanding among those who devoted considerable time to the diagnosis and treatment of these lesions. Possibly Braum (1906) was the first to

initiate intramedullary surgery of the spinal cord. Various syndromes resulting from intramedullary and extramedullary tumors were described, methods of performing osteoplastic laminectomies, hemilaminectomies and other technical features were brought forward by several authors. The syndromes of lesions at various levels of the cord were elaborated and voluminous writings appeared devoted to the subject, including a book on surgery of the spine and spinal cord by Frazier in 1918. A volume devoted to the diagnosis and treatment of surgical diseases of the spinal cord and its membranes by Elsberg was published in 1916 and in 1925 there appeared a monograph on tumors of the spinal cord by the same author. However, errors in localization and confusion over the positive preoperative identification of the presence or absence of intraspinal space-occupying lesions, made apparent the need for more precise methods of localizing spinal cord tumors, a need partly fulfilled by Sicard's method. Within the past decade many worthwhile articles concerning the diagnosis and treatment of spinal cord tumors have appeared in the literature but no major change in the fundamental principles of exposing and removing these lesions has been proposed.

In 1911, Middleton and Teacher described the posterior prolapse of an intervertebral disc which was impinging on the lumbar enlargement of the spinal cord. They found only one other reference on this subject (Kocher). Recently Love and Walsh quoted Virchow as having mentioned such a finding. The work of Schmorl and Andrae, whose researches have been summarized by Beadle (1931), has added much to our knowledge of this structure. Seemingly the lesions that we now recognize as herniations of the intervertebral disc into the spinal canal had previously been recorded under the caption, "chondromas of the intervertebral cartilage." Dandy, in 1929, described the removal of dislodged intervertebral cartilage in two patients suffering from cauda equina com-

pression and ascribed the etiology of the lesion to trauma. Mixter extended this work and soon a new syndrome was elaborated, that of retropulsion of the nucleus pulposus. The reports from the Mayo Clinic have elaborated upon the subject and accordingly have aided in the establishment of a fairly well delineated entity.

Tumors of the peripheral nerves and those arising from the sympathetic system have received attention and several noteworthy contributions concerning their treatment have been recorded. The surgical approach to these problems has undergone few significant changes during the past fifty years.

CRANIAL NERVE DYSFUNCTIONS

The operations devised for disorders affecting the cranial nerves have been palliative procedures consisting of partial or total division of the nerve supplying the motor or sensory field implicated. These surgical procedures are: intracranial section of the dorsal root of the fifth cranial nerve for tic douloureux and other painful afflictions involving the face, nose or mouth; extracranial interruption (anatomical or physiological) of the seventh nerve for certain facial spasms; partial or complete division of the eighth cranial nerve for the relief of Meniere's syndrome; division of the glossopharyngeal nerve for neuralgia; section of the cephalad third of the tenth cranial nerve for laryngeal pain; and cutting of the eleventh cranial nerve for spasmodic contractions of the sternomastoid muscle. In addition the eleventh and twelfth cranial nerves have been employed for spinofacial and hypoglossofacial anastomosis in an attempt to relieve facial spasms and as an aid in the restoration of function in instances of paralysis of the face.

The evolution of the surgical treatment of tic douloureux rather characteristically exemplifies the development of modern neurological surgery. The first recorded account of this disease, illustrated by the

picture of a physician, Johannes Laurentius Bausch, himself a sufferer of the malady, was published in 1671 but it was not until 1884 that the idea of operating on the Gasserian ganglion was set forth by J. Ewing Mears. Horsley was the first to perform an intracranial division of the second and third branches of the trigeminal nerve by the temporal route for tic douloureux on November 15, 1888. On December 11, 1890 a second patient was operated upon at which time Horsley attempted to excise the ganglion, but, with a fatal outcome. On April 2, 1890 Rose, another English surgeon, excised the ganglion piecemeal. The pain was relieved but the patient lost the eye on the affected side. On May 11, 1891 Novaro performed a partial resection of the ganglion which resulted in a cure. Andrews, an American, successfully operated upon a patient with major trigeminal neuralgia in 1891. In May 1892, Hartley perfected the technique of the temporal route which had been introduced by Horsley. By 1892, Rose had performed seven operations. Krause, following the lead of others, carried out the operation on thirty-three patients between 1893 and 1903 with only three failures. In 1890 Horsley, then Macewen and after him Princeteaux attempted preganglionic section of the nerve but all the patients died. In 1901, Frazier put into practice the retroganglionic operation that had been suggested to him by Spiller in 1898. In America the technical refinements in conducting this operation greatly decreased the mortality. In 1903, Van Gehuchten reported the results of his researches, showing that division of the posterior root resulted in a permanent destruction of the central part of the sensory pathway. In 1925, Frazier after having used the method for ten years advocated that only the outer part of the dorsal root be divided in order to spare the innervation of the cornea. His anatomical studies indicated that the disposition of the fibers of the dorsal root was such that cutting the outer two-thirds of this structure would spare the eye and the cutaneous

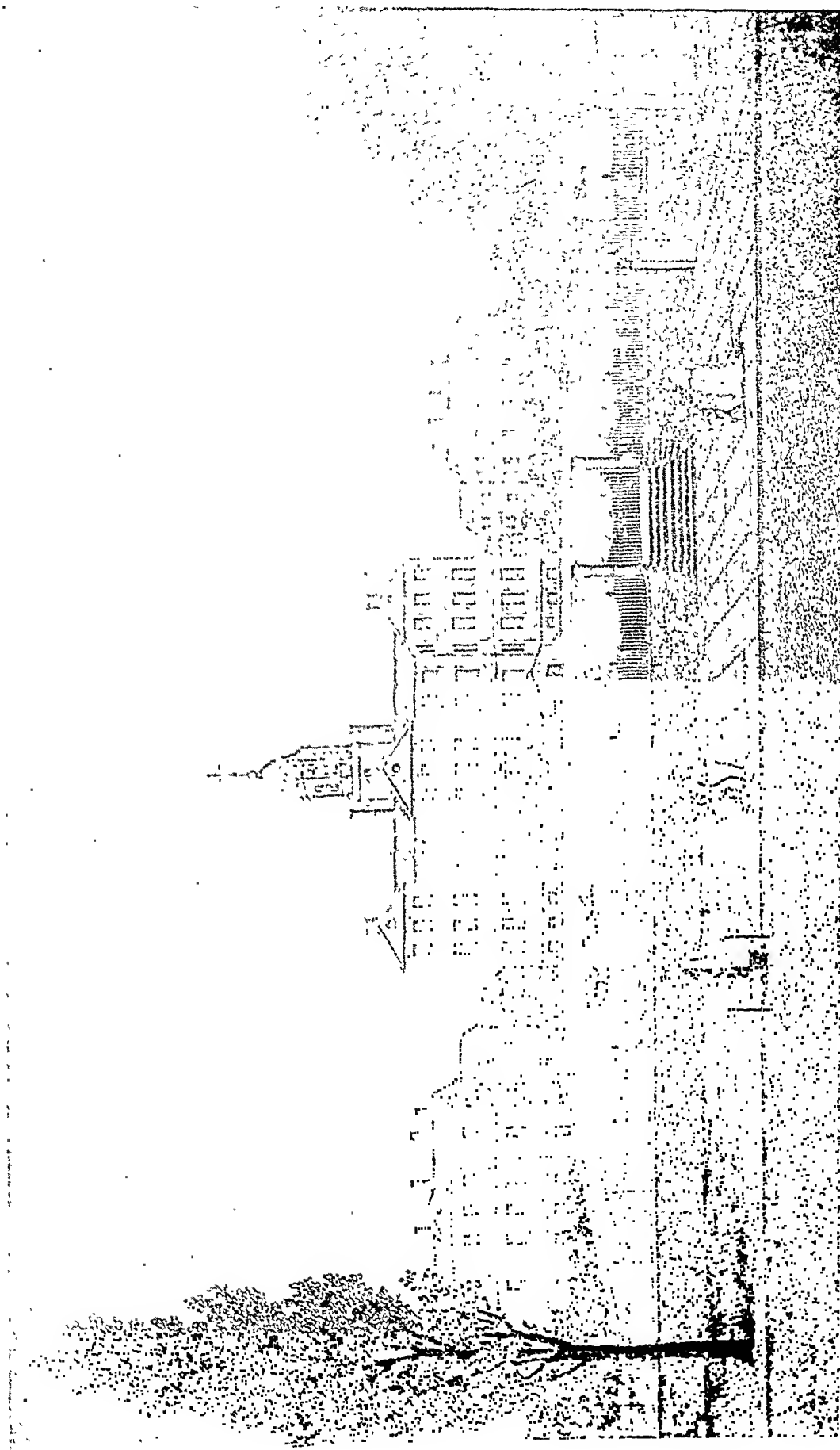
In 1920, Sicard and Robinson recorded their observations in a case of "algie velopharyngée essentielle" treated by avulsion of the glossopharyngeal nerve extracranially. In 1924, Adson reported his experience with four cases of glossopharyngeal neuralgia, two of which were treated by an extracranial division of the nerve. In the same article he advocated an intracranial operation for this disorder illustrated with drawings of the proposed procedure. Fay (1926) reported the intracranial section of the ninth cranial nerve in conjunction with division of the upper cervical spinal nerves for pain resulting from carcinoma of the throat. On April 6, 1927, Dandy performed the first intracranial section of the ninth cranial nerve for glossopharyngeal neuralgia. That paroxysmal pain referred to the throat and the region of the external auditory canal may be relieved by section of this nerve on the affected side, seems to be established. It has been recorded that syndromes closely allied to those designated as glossopharyngeal neuralgia have not been relieved by this procedure. The work of Bucy (1936) and the unpublished work of Tarlov seem to indicate that intracranial section of the cephalad third of the vagal fibers at the medulla is indicated for the relief of pain referred to the inferior pharynx and laryngeal areas.

Spasmodic torticollis has captured the attention of several investigators, the first available record of an operation being performed for this disorder is that of Keen (1891). The eleventh cranial nerve and the posterior roots of the first, second, and third cervical spinal nerves were divided. In 1893, Gardner and Giles claimed priority of three months over Keen for this operation but their work was not published until two years after Keen's article appeared. McKenzie (1924) reported the results of an intradural division of the spinal accessory nerve and the sensory and motor division of first, second, and third cervical nerves on the same side. (The operation was performed by Cushing.) Finney and Hughson (1925) reported on

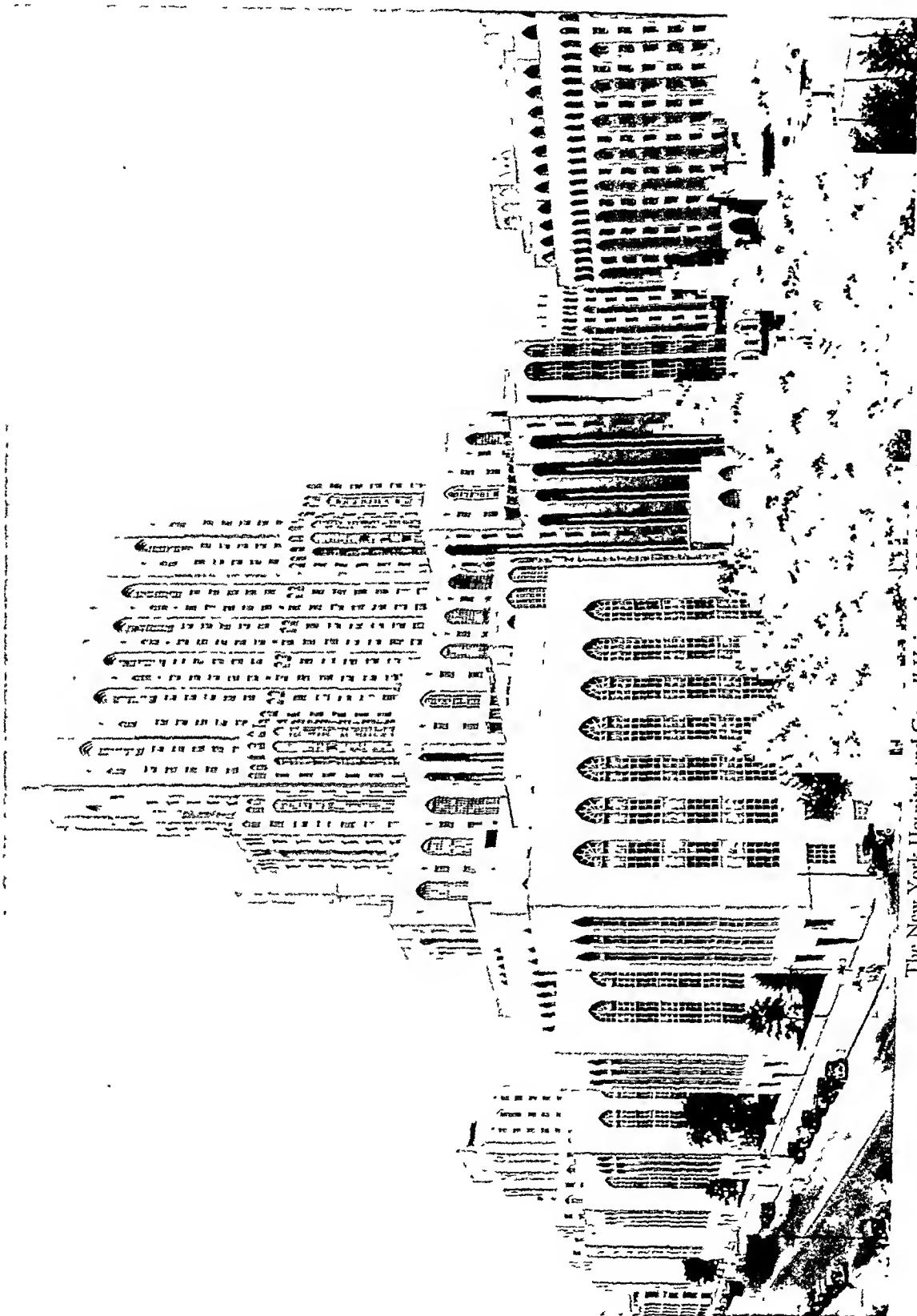
the extraspinal division of the upper cervical nerves together with the spinal accessory nerves for the treatment of torticollis. Dandy, in 1930, also reported his results in eight cases using the intradural approach for the division of the upper three cervical spinal roots on the affected side and the cutting of the spinal accessory nerve peripherally.

TRAUMA OF THE NERVOUS SYSTEM

The many manifestations of traumatic insults to the nervous system have attracted the attention of surgeons since ancient times as indicated by the writings in the earliest available literature. Among the first to investigate the problem of brain trauma, at least from the viewpoint of altered physiology, was Duret (1874, 1877 and 1878) and von Bergmann (1880). After the Listerian period, trephination was resorted to more frequently in the treatment of a great variety of cranial and intracranial lesions of traumatic origin. In 1886, the symptoms and signs of extradural hematoma were analyzed by Jacobson. Ball and Schneider (1888) reported the successful removal of an intracerebral clot formed in the tract of a knife wound. Championniere (1890) and Michaux (1890) recorded operative procedures for the removal of spontaneous cerebral blood clots. It was in 1857 that Virchow published a paper on pachymeningitis hemorrhagica interna, giving the first clear account of the membranes surrounding what has come to be known as chronic subdural hematoma. He also recognized the hydroma variation of this disorder. It is not clear just when operations were first performed for the removal of these surface clots. It is possible that the earliest trephinations may have disclosed collections of fluid blood in the subdural space in those instances in which the dura was either intentionally or inadvertently opened. In any event, Macewen (1889) read a paper before the British Medical Association in which he described three cases of blood clots removed "from the surface of the brain." Starr, writing in



The First New York Hospital Erected in 1775



The New York Hospital and Cornell University Medical College Today

1893, stated that between "the time of Macewen and the present" about thirty cases had been reported of successful removal of intracranial blood clots. The literature indicates that during the last decade of the nineteenth century surgical therapy for intracranial lesions of traumatic origin was for the most part restricted to compound fractures of the skull and intracranial hemorrhages.

At the turn of the present century the experimental work of Kocher and Cushing (1901, 1903) and the perfection of the decompression operation (Cushing) mark the beginning of a twenty year period during which there was a quite general adoption of the operative treatment of skull and brain injuries. The published reports relative to the subject are too numerous to mention. The ineffectiveness of the decompression operation in the treatment of many types of brain trauma became more evident when this method of treatment was carried out on a large scale during World War I. Weed and McKibben (1919) reported that intracranial pressure could be influenced by altering the osmotic pressure of the blood through the intravenous introduction of hypertonic and hypotonic solutions. Then followed a period of nonoperative treatment of patients with brain injuries, hypertonic solutions of dextrose, sucrose, and sodium chloride being used intravenously in an attempt to reduce increased intracranial tension resulting from trauma. Several articles have appeared presenting evidence in support of the nonoperative treatment of brain trauma and others, questioning the advisability of continuing the use of these hypertonic solutions as is now so popular. The general application of the nonoperative treatment of head injuries has tended to retard the acceptance of certain advances made in the operative therapy as applied to subdural hematoma in particular. Naffziger (1924) reported on subdural hydroma and in 1925 the excellent article by Putnam and Cushing concerning chronic subdural hematoma appeared. It is to Munro (1934, 1936,

1938) that the credit belongs for a careful analysis of the symptoms, signs and treatment of the different subdural lesions of traumatic origin that may result from trauma to the head. Peet and Kahn's review (1934) of the subject pertaining to the occurrence of the lesion in children produced a renewed interest in the treatment of subdural collections resulting from birth injury. Munro's recent book (1938) and that of Brock (1940) summarize the present state of our knowledge relative to the subject of brain trauma.

Operations on the spine for fracture are not of recent origin. In the seventh century, Paul of Aegina, recommended incision of the soft parts and removal of fractured laminae. Ambrose Paré and his contemporaries operated for fracture of the spine. In 1850, Brown-Sequard described the syndrome that we now designate by his name. During the latter half of the nineteenth century there were recorded many descriptions of the findings, both clinical and pathological, following injury of the spinal cord at various levels. Laminectomy was rather frequently resorted to as a therapeutic measure particularly after the Listerian period. The idea of operating for fracture of a vertebra was carried over into the present day, and in 1916, Elsberg, in a monograph on the "Diagnosis and Treatment of Surgical Diseases of the Spinal Cord and its Membranes," stated that he advised operation in instances of incomplete physiological interruption of the spinal cord resulting from trauma. Lumbar puncture to determine the presence or absence of blood was also suggested. The work of Head and his associates during the last World War deserves special mention. For the next decade little was added to our knowledge apart from pathological descriptions of the lesions to be found at operation or autopsy, such as was published by Thomson in 1923. Then in 1925 Coleman advocated the use of the Queckenstedt test for determination of the presence or absence of spinal cord compression. Slowly a conservative attitude was adopted and as

Coleman suggested, only those cases showing evidence of partial or complete block of the spinal subarachnoid space were subjected to laminectomy. Today there is little that can be added to this, save for the gradual realization that in instances of fracture-dislocation of the cervical vertebrae with associated spinal cord injury, operation is seldom of benefit regardless of the patency of the spinal subarachnoid space. A significant advance in the conservative treatment of patients suffering from fracture-dislocation of the cervical vertebrae with associated spinal cord injury has been the use of tongs advocated by Crutchfield in 1933 (suggested by Coleman in 1932), as a means of applying skeletal traction. The application of the work of Holmes (1935) and of Denny-Brown and Robertson (1933) relative to urinary bladder paralysis has been advantageous in those cases of bladder dysfunction resulting from spinal cord injuries as has also been the institution of tidal drainage as advocated by Munro and Hahn (1935).

It is not clear just when the first end-to-end anastomosis was performed upon peripheral nerves. The tenet of immediate suture of divided nerves, now so generally accepted, was not universally understood in 1890 when neurosurgery stood on the threshold of a rapid development. Cantile, lecturing before students in 1889 said that in simple division of a nerve, as in traumatic severance, it was not necessary to suture the divided ends, but that merely placing the parts at rest would allow union of the nerves. Duncan, on the other hand, in 1892, cited the excellent outcome of two cases of immediate suture of divided peripheral nerves, and emphasized the importance of immediate surgical interference. Elaborations upon the simple end-to-end procedure are not of recent origin. Letievant, in 1872, described the so-called flap method of suturing nerves in which there was a gap to be bridged. The method has proved unsatisfactory and is seldom used today. Suture *à distance* was originated by

Assaky in 1886, designed to provide a guiding framework of catgut for the down-growing axones. The method of nerve implantation, that is, implanting a peripheral segment of the divided nerve into an adjacent healthy nerve trunk, was proposed by Letievant in 1873 and adopted clinically by Despres three years later. Siek and Sanger, in 1897, reported the first successful case using this procedure.

According to Stookey the first nerve graft in human surgery was performed by Albert in 1878. Huber (1895) reviewed cases recorded in the literature in which this method had been employed. Schuller was the first to point out the possibility of gaining additional length in divided nerve segments by the process of stretching. During World War I the value of direct end-to-end suture performed immediately, or as soon as possible after the division of a nerve, was recognized as the best method. The experience of many with large numbers of cases during this period led to the publication of several noteworthy articles describing the various phases of this branch of surgery. Head's "human experiment" was accorded considerable prominence (1920). Among the more important recent contributions on this subject is the monograph of Pollack and Davis (1932).

PYOGENIC INFECTIONS

No doubt inflammatory diseases of the central nervous system, especially meningitis and brain abscess were known and treated by trephination during the pre-Christian era. Occasional scanty reference may be found concerning these infections particularly in association with fractures of the skull. In 1665, Peter de Marchettis wrote, "I remember having a consultation with the famous D. Julio Sala, professor at Pavia, about a man who had been wounded in the head with a dagger. Not only was the bone injured, but the membranes and even the brain. The external wound had been treated by a certain practitioner and a cicatrix had formed. After two or three months the patient was troubled with

epilepsy and had a fit twice or three times a month. When asked by Professor Sala whether he had ever had an injury to the head, he replied that he had, and pointed out the place. I immediately inserted a probe beneath the crust, and found a penetrating wound, and proceeded at once to open the parts. The next day I applied the trephine; yellow pus escaped. For twenty days I applied over the brain black western balsam, with the use of which the wound granulated, and in thirty days the patient was cured of his wound and of his epilepsy."

During the first half of the nineteenth century several reports indicate an interest in cerebral abscesses. Considerable information concerning cerebral localization was derived from the earlier encounters with such infections of the brain. Broca was the first to trephine (1861) for abscess of the brain diagnosed by the then new theory of cerebral localization. The pathological description of abscess of the brain, preceded the systematic operative intervention for the treatment of the disease. Hooper, (1826) published a beautiful illustration of encysted abscess and spreading suppuration of the brain. Cruveilhier published a picture of a temporosphenoidal abscess in 1835, and Bright of the same type of lesion in 1831, including an illustration of the temporal bone disease from which it presumably arose. Auvert, in 1851, gave the first illustration to be found in the literature of cerebellar abscess. The first full and critical account of brain abscess was published by Lebert in 1856 and was based on the records of eighty cases. In 1887, Schwartz successfully operated on a cerebellar abscess. To Macewen goes the credit for the major literary contribution in this field. His book, "Pyogenic Infective Diseases of the Brain," (1893) was perhaps his outstanding contribution to craniocerebral surgery. His recorded successes in the treatment of brain abscess matches if not surpasses many of the present day therapeutic attempts. For the treatment of brain ab-

scesses he advised that a decalcified femur of a chicken be used as a drain.

Aside from this method of Macewen, most measures employed surgically were those of trephination and drainage by means of wicks, and the frequent consequence was cerebral fungus, meningitis and death. It appears that little advance was made in the treatment of brain abscess until Moshier, in 1916, began his experiments with drainage material and evolved a copper wire "basket" which has come to be known as the Moshier drain. In 1925, Cahill reported twelve cases of cerebral and cerebellar abscesses treated by this method without a fatality. Adson (1920) recorded his results following utilization of an osteoplastic flap with drainage through an opening in the base of the flap. In 1924, King described a method of therapy accomplished by the creation of a rather large cranial defect directly over the abscess cavity and complete unroofing of the cavity thus permitting the lesion to herniate. King's method ran counter to the then accepted method of attempting to prevent herniation. In 1926, Dandy advocated "tapping" of the abscess thereby eliminating continuous drainage. This method of treatment has not been generally adopted. Horrax, in 1934, described a procedure, first suggested by Cushing some ten or twelve years earlier, for chronic encapsulated abscesses. This he termed "marsupialization of the abscess." In 1935, Adson and Craig reported a procedure somewhat similar to that used by Horrax. In 1936, King recommended the unroofing of the abscess cavity, the careful inspection of its interior and packing the abscess with a "handkerchief" of iodoform gauze. Repeated irrigation was carried out and herniation controlled by lumbar punctures. Several surgeons have recorded instances of complete extirpation of chronic abscesses, however, the indications for this method of treatment are not frequent. The part that chemotherapy may play in the treatment of brain abscess cannot be evaluated at the present time.

That the disease, spinal epidural abscess, was known over a century ago is indicated by the early reports on this subject by Bergemeschi in 1820, Albers in 1833, and by Bristowe in 1855. Donati (1906) and Schmalz (1925) presented excellent summaries of the situation. The view that these spinal infections may be secondary to an osteomyelitis of the vertebra was first proposed by Ramsey Hunt in 1904. The treatment, laminectomy, with wide exposure and drainage of the abscess seems to be accepted. That the clinical entity is gaining recognition is indicated by the recent articles of Slaughter, Fremont-Smith and Munro (1934) and Cohen (1938) who report cases of spinal epidural abscess correctly diagnosed and operated upon before the appearance of neurological symptoms or signs.

SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM

As has been said regarding the development of the surgery of the central nervous system, there are a few investigators whose anatomical and physiological observations have been the foundation stones for a proper understanding of the sympathetic nervous system. Outstanding among these are the contributions of Winslow (1732), Neubauer (1772), John Hunter (1776), Bichat (1802), Von Kölliker (1852) and Claude Bernard (1878). Alexander (1889) has been credited with the performance of the first operation on the sympathetic nervous system. This was a cervical sympathectomy for epilepsy. In 1896, Jonnesco recorded the results in a group of epileptics treated by this method. In 1899, Jaboulay resected the lower cervical sympathetic chain for exophthalmic goiter. There the matter rested until 1913 when Leriche called attention to the effect of periarterial sympathectomy on the circulation in the extremities. Further attention was attracted to this field when Jonnesco (1916) on the basis of the work of Francois-Franck, performed the first successful oper-

ation on the sympathetic system, removal of the stellate ganglion for angina pectoris. Then followed the work by Hunter and Royle (1924) ramisectomy for spastic paralysis and their personal presentation of the subject in the United States which truly marks the beginning of a wide-spread interest in the possibility of operating on the sympathetic system for a variety of disorders. Although the results in those cases for which the operation of Hunter and Royle was proposed were not enduring, as a by-product the operation of Wade (1927) for congenital megacolon and several procedures for the treatment of peripheral vascular diseases were evolved. The technical modifications of the original Wade operation have been many, the important ones in this country having emanated from Adson and his coworkers.

The first operation for the relief of symptoms resulting from vasospasm or the commonest cause of this disorder, Raynaud's disease, was performed by Veillet and Thibaudet in 1918. The work was extended by Bruning and Stahl in particular. Leriche contributed generously toward advancement of this form of treatment, however, in the main, periarterial sympathectomy was employed as a procedure of choice. The stellate ganglion had been surgically approached through the anterior cervical incision until it was proposed by Henry (1922) that the sympathetic trunk at this site would be more adequately exposed by a dorsal route. This idea was put into practice by Adson for the first time in 1928. Royle (1928) reported his operation for the treatment of Raynaud's disease. Improvement in technical features and the results following different operative procedures have been recorded by Adson, Gask, Leriche, White and others. In 1938, Smithwick presented a new operation to replace the cervicodorsal sympathetic ganglionectomy. Following this procedure the undesirable effects of section of the post-ganglionic fibers to the upper extremities were avoided and the relief of symptoms of Raynaud's disease were enduring.

After Jonnesco's report in 1920 on the surgical treatment of angina pectoris, a great variety of operations on the cervical sympathetic system were devised and carried out. In 1925, Reid and Andrus, reviewing the subject, were able to find fifty cases of angina pectoris treated by operations on the sympathetic nervous system. They listed the procedures employed up to that time: (1) excision of the lower cervical and first thoracic ganglia and the intervening cord; (2) excision of the entire cervical chain including the stellate ganglion; (3) division of the cervical sympathetic trunk and the superior cardiac nerve; (4) excision of the superior cervical ganglion; (5) excision of the middle cervical ganglion; (6) removal of the superior and middle cervical ganglia and intervening trunk; (7) excision of the middle and inferior cervical ganglia and sympathetic cord; (8) extirpation of all cervical ganglia and the sympathetic cord; (9) resection of the depressor nerve; (10) resection of the dorsal root of the second left thoracic nerve; (11) indefinite procedures. They concluded that the operation which had been most successful was removal of the stellate ganglion and all or a major part of the cervical trunk.

During the past fifteen years many contributions to the subject have appeared in the literature including chapters in several monographs, the outstanding one dealing with surgery on the sympathetic nervous system being that by White (1935). Following the introduction of paravertebral alcohol injection for the relief of pain of cardiac and aortic origin by Mandl (1925) and by Swetlow (1926) operative procedures have not been so frequently advocated. This method of treatment has been greatly amplified by the work of White.

In 1889, Bradford published observations to the effect that stimulation of the anterior roots of the spinal nerves, from the sixth thoracic to the second lumbar, caused a rise in blood pressure and contraction of the kidney. The greatest reaction was obtained by stimulation of the spinal roots of the ninth thoracic to the second lumbar

spinal nerves inclusive. In 1923, Bruning suggested sympathectomy for control of arterial hypertension, and the same year Daniélopou suggested operation on the splanchnic nerves for this condition. Two years later Rowntree and Adson reported a case of malignant hypertension treated by bilateral lumbar sympathetic ganglionectomy. Section of the splanchnic nerves for arterial hypertension was first performed by Pieri in May 1930, but this operation was limited to one side. In 1934, Craig cut the splanchnic nerves through a subdiaphragmatic approach, and in 1935 Peet published a report on bilateral splanchnic nerve section as carried out in over sixty patients with favorable results in a large proportion of the cases. In 1934, Adson and then Heuer sectioned the anterior spinal nerve roots from the sixth thoracic to and including the second lumbar root in an attempt to reduce excessive arterial tension. Crile advocated the treatment of hypertension by excision of the celiac ganglion and denervation of the aortic plexus. Many workers have been attracted to this field of surgical endeavor and in general the results have at least matched and in some cases bettered those obtained by the conservative methods of therapy, but a satisfactory and generally applicable means of dealing with this disorder remains to be devised.

In addition to these surgical procedures that have been quite generally adopted, operations upon the sympathetic system have been devised for a great variety of disorders. Ganglionectomy for hyperhidrosis, Kotzareff (1921), Braenker (1928), Adson (1932); sympathectomy for thromboangiitis obliterans, Diez (1931); Adson (1932); cervical ganglionectomy, Dandy (1931) for hemicrania; relief of certain types of abdominal pain by ramisectomy, Scrimger (1929); cervical sympathectomy for atypical facial neuralgia, Frazier (1928), Fay (1932); facial paralysis, Leriche (1926), etc.

Jaboulay made the first attempt to relieve pelvic pain by dividing pelvic sympathetic

nerves through a retrorectal approach, (1899). Ruggi, in 1899, advocated resection of the utero-ovarian plexus by way of a transperitoneal route. Leriche (1921 and 1925) introduced periarterial sympathectomy of the internal iliac arteries for dysmenorrhea, and in 1925 Cotte described resection of the superior hypogastric plexus (termed by Latarjet and Bonnet the presacral nerve). Herman is said to have been the first American surgeon to perform this operation. Since then Adson and Masson, Greenhill and Schmitz, Counseller and Craig, Abbott, White, Wetherell, De-Courcy, Keen and others have recorded favorable results obtained by resection of the presacral nerve in cases of intractable pelvic pain from disease of the urinary bladder, uterus, rectum and other pathological and pathophysiological states of this anatomical region. The operation of presacral neurectomy has been advocated for the relief of obstipation associated with Hirschsprung's disease, but the production of sterility by the procedure has militated against its use in this condition.

MISCELLANEOUS

The arteries of the intracranial cavity may undergo pathological changes that result in aneurysmal formations at many sites, however, the saecular aneurysms of the intraeranian portion of the internal carotid artery, the fistulous aneurysms of the carotid-cavernous type, and the small saecular aneurysms arising from the circle of Willis have been attacked by the surgeon. In addition may be mentioned the congenital arterial, arteriovenous and venous malformations of the blood vessels of the brain itself. For the treatment of all these conditions extraeranian ligation of the internal carotid artery or ligation of the common carotid has been practieed. In many instances the carotid ligation was carried out without a more critial study or knowledge of the situation being made than that afforded by physieal examination. It appears that Benjamin Travers (1809) was the first to perform ligation of the carotid

artery for pulsating exophthalmos. The operation of carotid ligation for many conditions, trigeminal neuralgia, epilepsy, the pyschoses, etc., was practised during the first half of the nineteenth century. Pilz (1868) published a paper on ligation of the common carotid artery based on six hundred cases with a total mortality of 43 per cent. Numerous reports have appeared regarding the use of carotid ligation for vascular tumors of the scalp as well as for pulsating exophthalmos. It is within recent years that the principle of proximal arterial ligation has been applied to the group of saecular intracranial aneurysms. Several such lesions have been exposed by intracranial exploratory operations and the carotid artery ligated proximal to the lesion at a later date. The introduction of cerebral angiography by Moniz (1927) placed the final diagnostic procedure for these lesions of the blood vessels in the hands of the surgeon and as a consequence the operation of carotid ligation for saecular intracranial aneurysms is being more widely employed. Hamby and Gardner (1933) practiced both proximal and distal ligation of the fistulous aneurysms of the carotid-cavernous type. Dandy (1935) suggested the use of clips to close the internal carotid artery distal to the aneurysm following a previous extraeranian ligation of the artery proximal to the lesion. Dott (1933) applied fascial strips about a small saecular aneurysm of the cirele of Willis. Dandy (1938) carried out both proximal and distal ligation for saecular aneurysm of the intraeranian portion of the internal carotid artery.

It would seem from a comparison of the writings that appeared some fifty years ago with the publications of today that many of the same etiological factors were assigned to convulsive disorders then as now. Furthermore, the reported results following surgical therapy are not very encouraging. There has been less advance in the treatment of "essential" epilepsy than any other condition with which the neurological surgeon is required to deal. It is difficult to trace the earliest writings on this subject.

It is probable that some of the trephine openings found in the skulls of the pre-Christian age were made to let out spirits which were blamed for inciting their host to fits. Aside from this speculation, there are well documented reports to be found in the writing of Starr whose book was published in 1893 concerning the operations for convulsive disorders, including a chapter devoted to epilepsy. The cases of traumatic origin were considered most favorable. If upon exposing the area of brain under suspicion no discernible lesion was found, faradic current was used to stimulate the cortex and the area responding to the minimal stimulus was considered a focus of origin for the fit and therefore excised. It was considered that from such a focus the extension of the fit occurred "like a ripple of a pond when a stone is thrown into it." The paralysis resulting from such an excision, for usually this would be in the vicinity of the motor area, gradually passed away, and in some cases the disease was cured. Laurient (1891) collected one hundred and two cases of trephination for epilepsy; 54 per cent were stated to have been cured. Agnew (1891) collected fifty-seven additional cases, although the results in this series were not as good. Starr included a detailed account of the gross pathological changes found at operation and careful histological studies of the excised cortex. Interesting records of the earlier experience with this disease reveal a boldness of attack by surgeons who are frequently considered, by the uninformed of today, to have been hopelessly unfamiliar with such problems. The enormous literature that has accumulated regarding the diagnosis and treatment of patients with recurring convulsive seizures indicates an attitude of perseverance unparalleled in any other problem confronting the surgeon. Much has been accomplished in that many lesions of a gross organic nature are identifiable by Dandy's method of cerebral aerography. The etiology of so-called cerebral dysrhythmia appears to be as obscure today as it

was fifty years ago. In more recent years Foerster in Germany and Penfield in Canada have worked on this problem, perhaps more than others. Recently Berger's (1929) electroencephalographic method has given impetus to further study; however, this diagnostic procedure has not as yet given the indications for effective therapy.

The experimental work of Dandy (1913, 1917, 1919) together with the work of Weed, laid the foundation for the present-day concepts of the mechanisms of the production of hydrocephalus. In addition to this, Dandy has, in a series of papers, described means for extirpating the choroid plexuses of the lateral ventricles (1918, 1922) and of the fourth ventricle (1938) and described operative attack on the problem of stenosis of the aqueduct of Sylvius (1920) and an operation (1921) designed to provide access for fluid into the general spinal subarachnoid circulation that has been retained within the ventricular system through occlusion of the foramina of Magendie and Lusckha. Putman (1934) reported his results following electrocoagulation for essential hydrocephalus.

Operation for the various malformations of the spinal cord and its coverings occupied a prominent place in the writings of fifty years ago (Von Bergmann 1889). Several minor innovations have been introduced during the last half century concerning the surgical treatment of these lesions. Penfield and Cone advocated infolding instead of extirpating the involved meninges. There is still much to be desired in the surgical treatment of the congenital disorders of both the intracranial and the intraspinal structures.

Another advance in surgery for the relief of intractable pain was made when Spiller advised section of the anterolateral columns of the spinal cord. And thus it was that on January 19, 1911, Martin carried into practice the idea of his confrere and performed the first cordotomy through a laminectomy of the sixth, seventh and eighth dorsal vertebrae. The patient was

a poor witness and the results of the procedure were admittedly difficult to evaluate, but Spiller and Martin were satisfied that at least a considerable if not total alleviation of the pain had been effected. The procedure is advocated by many surgeons, however, it seems that the operation has only a limited applicability.

In 1920, Hassin stated that he had seen Meyer perform an operation for syringomyelia but the outcome of the procedure was not mentioned. Considerable space was devoted to this subject in the Oxford Loose Leaf Medicine by Collier the following year and in 1926, Pousepp was the first to report on the results of the procedure. Rare articles have appeared concerning the cure of this malady by incision into the cavities of the cord with release of the encysted fluid, and in 1930, Frazier, and in 1931, Putnam, published further observations following this operation.

The discovery by Bell and Magendie respectively, about a century ago, of the function of the anterior and posterior roots, laid the foundation for attempts to interrupt the latter in painful afflictions. Such a suggestion was first made in this country by Dana and in England by Bennett. The first rhizotomy was performed by Bennett (December 24, 1888) with section of the left lumbar and the first and second sacral posterior spinal roots intradurally, but unfortunately the patient died on the twelfth postoperative day. The relief from pain had been complete from shortly after operation until death. The second rhizotomy was carried out by Abbe (December 31, 1888). The sixth and seventh cervical spinal nerves on the right side were cut extradurally in a forty-four year old man suffering from violent pain and spasmodic movements in stump of the right arm, the result of amputation. For two years after Abbe's operation the patient was well and abandoned the morphia habit, but four years following operation pain in the stump recurred and a drawing sensation was referred to the fingers although the area of cutaneous anesthesia remained unal-

tered. Foerster has had extensive experience with rhizotomies and as a by-product of his work we have a record of carefully charted resultant sensory loss, following root section of all spinal levels. Foerster and Schuller were probably the first to suggest posterior rhizotomies for certain spastic conditions and it was following such operations that observations were made relative to the increased skin temperatures in the denervated area. From this came the idea of posterior root section designed to improve the blood flow in extremities.

Horsley (1909) described an operation for the relief of the slow vermicular movements commonly termed athetosis. According to Putnam (1939) success with Horsley's operation had been reported by Anschutz, Payt, Mazaroff and Sachs. In 1931, Putnam recorded the results following cordotomy in the cervical region for unilateral and generalized athetosis. Bucy and Buchanan (1932) and Bucy and Case (1937) reported on the effect of extirpation of area six (Brodmann) in instances of athetosis.

Following the observation by Fulton and Jacobsen in 1935 that primates in whom a bilateral prefrontal lobectomy had been performed were not easily made neurotic by the presentation of problems difficult of solution and the report by Brickner and Ackerly in 1934 that a considerable portion of the prefrontal areas may be removed in man (they studied a lobectomized human) without lowering of the general intellectual level, Moniz performed prefrontal lobotomies in patients with psychoses. A paper published in 1936 indicated that this operation had been performed by him in twenty cases and that good results were obtained in those suffering from agitated depression psychosis. Freeman and Watts in this country recorded a case shortly after the paper of Moniz appeared. In this communication they state that Moniz had performed the operation on twenty additional patients. Subsequently, Freeman and Watts published a report on the

operation after experiences with forty-eight cases (1939). The possibility of altering pathological, physiological or abnormal psychological states by dividing seemingly normal structures of the nervous system has attracted the attention of a few surgeons within recent years and bids fair to open a new approach to several problems heretofore not considered amenable to surgical therapy.

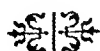
Any historical account, however deficient, which carries the reader up to the present day, could logically include a prediction for the future. This I refuse to attempt although it may be said that the horizon for further advances in neurological surgery appears boundless. Especially in America where internal strife and periodic wars have not diverted the attention of men capable of deductive synthesis, there should be a constant increase in the flowering of productive thought. The safeguard for the years to come is the retention of students of an intellectual order that will permit ingraftment of the knowledge already attained and the inculcation of a desire to devote a substantial portion of their time to scientific investigation.

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FIFTY YEARS OF OPHTHALMOLOGY IN THE UNITED STATES*

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DURING the past fifty years, definite advances have been made in surgical technic, in diagnosis, and in immunologic, chemotherapeutic and orthoptic treatment as well as in other therapeutic measures to combat eye diseases; yet modern ophthalmologists could learn much from the older practitioners concerning the practice of medicine. In spite of excellent contributions by Derby,¹ Riggs and Lunt,² Rutherford³ and others, more consideration should be given to the psychology of patients and particularly the mental disturbances which almost invariably accompany ocular disease. This subject first received active consideration in 1913, when psychoanalysis began to stress the symbolic significance of the eye: Dunbar⁴ has published a large number of abstracts from articles on psychic factors in eye affections. Mental disturbances after operations on the eye have been described by Posey.⁵ Posey, de Schweinitz and Holloway added greatly to modern knowledge of neuro-ophthalmology; Posey collaborated with Spiller in writing a textbook on neurology of the eye.

Posey also contributed to our knowledge of the hygiene of the eye and was associated with the remarkable progress made in preventing blindness. Park Lewis and Howe pioneered in the movement to conserve vision through the prevention of accidents, ophthalmia neonatorum and other diseases, improved methods of treatment, better understanding of hereditary defects and especially through the education of the public by the organization of the National Society for the Prevention of Blindness. Sight-saving classes for the visually handicapped have been developed in the United

States during the last few years, mainly through the work of Winifred Hathaway, and the development of social service in ophthalmology has made marked progress in the last few years largely due to studies on this subject contributed by Derby.⁶

Great impetus has been given to the improvement of the teaching of ophthalmology through the development of examinations for the certificate of the American Board of Ophthalmology. This Board which was the first of the surgical specialty boards, was originally suggested by Dr. Edward Jackson. He was aided in the organization work in 1915 by the following committee: Walter B. Lancaster, Wendell Reber, Frank C. Todd, Edward C. Ellett, Hiram Woods, Myles Standish, William H. Wilder and Alexander Duane. Judd Beach, the historian of the Board, has compiled a history of ophthalmology for the years 1908 to 1915. During these years the foundation of the Board was laid. Since that time ophthalmology has made many advances not only in teaching but also in regulating requirements for the preliminary training of ophthalmologists. Moreover, educational standards for ophthalmologists⁷ have been gradually raised.

Clinic practice, which is so important in preventing blindness, has improved and standards for out-patient service in ophthalmology⁸ have been prepared by the Committee on Standards for Out-Patient Service in Ophthalmology of the New York Academy of Medicine. These standards illustrate modern trends in ophthalmic examinations and recommend standard equipment for eye clinics. The standardization of the preparation of drugs employed in ophthalmology has been studied by

* Aided by a grant from the Ophthalmological Foundation, Inc.

Hasler.⁹ His method consists in preserving eye solutions by the addition of nipagin-nipazol, which is nontoxic to man, non-irritating to the eye and sterilizes and prevents contamination of eye solutions.

Development of research in ophthalmology has progressed rapidly during the last fifty years with the establishment of several foundations and institutions devoted to research. The first institutions actually performing organized research were: the Wilmer Institute, Washington University (St. Louis), Howe Laboratory at Cambridge and the Presbyterian Institute of Ophthalmology. Among the foundations, the Wilmer, Knapp, Markle, Schnyder and Ophthalmological, have done and will do much to advance the science of ophthalmology and prevent blindness. The Wilmer Institute under Wilmer and Woods, the Presbyterian Institute of Ophthalmology under Wheeler, Dunnington and Thygeson, the Howe Laboratory under Verhoeff and several departments of ophthalmology, as that at Washington University under Post, another at the University of Iowa under O'Brien, the Department of Research at the Brooklyn Eye and Ear Hospital under Evans and the Research Department of the New York Eye and Ear Infirmary are in a position to contribute. The Dartmouth Eye Institute founded by Ames in 1919 has made notable contributions especially in the field of binocular vision and space perception. Several institutions are developing departments of research similar to that under Adler at the University of Pennsylvania. The American Academy of Ophthalmology and Otolaryngology, the Section on Ophthalmology of the American Medical Association and the American Ophthalmological Society have cooperated in promoting research and in considering many ophthalmologic problems.

The Association for Research in Ophthalmology was organized in 1930. Its first president was William H. Wilmer, and its first secretary, Eugene M. Blake. The early

meetings of the Association were devoted to the study of uveal infections.

Among the oldest eye institutions in America which have contributed greatly to the development of ophthalmology are the New York Eye and Ear Infirmary (founded in 1820), Brooklyn Eye and Ear Hospital (1868), the Manhattan Eye, Ear and Throat Hospital (1869), the Hermann Knapp Memorial Hospital (1869) and the Massachusetts Charitable Eye and Ear Infirmary (1899). In 1935, the Section on Ophthalmology of the New York Academy of Medicine was 50 years old.

FOCAL INFECTIONS

Focal infections in relation to inflammatory diseases of the eye have assumed increased importance since Billings' original contribution in 1912.¹⁰ The importance of gastrointestinal intoxication, teeth, paranasal sinuses, prostate, gallbladder and pelvic organs in the pathogenesis of chronic uveitis was stressed by de Schweinitz in 1913.¹¹ In 1916, Frank Billings¹² published his classic lecture on focal infections.

Elective localization in the eye of bacteria from infected teeth was discussed by Meiser and Gardner¹³ in 1922 and Haden¹⁴ in 1923. In 1932, Rosenow and Nickel¹⁵ discussed elective localization in determining the etiology of chronic uveitis. In the study of focal infection some progress has been made in differentiating bacteria by *in vitro* tests.¹⁶ The study of ocular infections in brucellosis (undulant fever) has received increased incentive through the work of Green.¹⁷

Immunologic factors in infections of the eyes have been investigated by numerous workers. Woods has made a number of valuable studies on ocular anaphylaxis. His book on "Allergy and Immunity in Ophthalmology" is an outstanding contribution. In 1917,¹⁸ he studied Elschnig's theory of allergy and described a treatment which consists in desensitization with uveal pigment until immunity is produced. In 1927, Woods and Burky¹⁹ described the preparation and immunologic and chemical

properties of lens protein and its fractions. In 1933, Woods and Little²⁰ published an article on the hypersensitivity and therapeutics of uveal pigment.

UVEAL TRACT

Valuable contributions to our knowledge of the etiology of iritis have been made by Irons and Brown.²¹ These workers in association with Nadler²² studied experimental iridocyclitis in rabbits and investigated the localization of streptococci in the eye. Iritis has been produced experimentally in rabbits' eyes by the intracutaneous sensitization and intravenous intoxication with living streptococci by MacLean.²³ Seegal, Seegal and Khorazo²⁴ demonstrated that if a nonspecific inflammation is produced in the eyes of experimental animals or if the eyes are traumatized while an antigen is circulating in the blood stream, the antigen is absorbed directly in the eye and produces ocular sensitization.

The bacteriologic and immunologic considerations of chronic uveitis have been studied by Brown²⁵ who showed that ocular sensitivity from a remote infected agar implant may occur on the third day.

The role of intraocular typhoid antibody content in the treatment of uveitis has also been studied by Brown.²⁶

CHOROID

Sympathetic Ophthalmitis. Much thought has been given to sympathetic ophthalmitis; in 1919 Knapp²⁷ discussed the auto-toxic factor. The theory of a virus as the cause of sympathetic ophthalmitis was advanced by Gifford and Lucic.²⁸ Sensitization to uveal pigment in the etiology of sympathetic ophthalmitis and the use of uveal pigment in the diagnosis and treatment of this disease has been discussed by Alan Woods.²⁹

Adequate statistical data to evaluate the efficacy of massive doses of diphtheria antitoxin, as suggested by Verhoeff³⁰ for the treatment of sympathetic uveitis, are still not available. In 1934, Friedenwald³¹ excised an area of skin injected with a test

dose of uveal pigment. He found that in patients with sympathetic ophthalmitis, the skin excised fourteen days after injection showed marked cellular infiltration with round cells, epithelioid cells and giant cells, and almost complete phagocytosis of the injected pigment. In normal and insensitive individuals there was practically no cellular reaction and little phagocytosis of pigment.

Tumors. Knowledge concerning prognosis in tumors of the choroid has been enhanced by Callender and Wilder,³² who have classified malignant ocular melanomas according to their argyrophil fiber content. The outstanding facts brought forth by this study are that no deaths have occurred from any spindle cell subtype A or fiber group 3 tumors and that the patients in all cases in which no argyrophil fibers appear among the tumor cells have died.

OPERATIONS ON THE IRIS

In 1891, Smith³³ described his modification of Critchett's operation of iridodesis for iridodialysis; the iris was drawn into a small peripheral wound. Modifications of this technic have been proposed by Jameson,³⁴ Key³⁵ and Bulson.³⁶

Rones³⁷ has described the Wilmer iridocapsulectomy for occluded pupil.

GLAUCOMA

Pathogenesis. Friedenwald and Pierce³⁸ have experimentally studied the pathogenesis of acute glaucoma. The secondary fall in pressure, observed by these investigators in animals after the injection of histamine into the vitreous or anterior chamber, resembles the hypotensive stage which occurs in acute glaucoma relieved by miotics without operation.

Incipient Glaucoma. In a study of the effects of mydriatics upon intraocular tension Gradle³⁹ concluded that in persons past 30 years of age tonometric measurements made immediately before and directly after the use of a mydriatic or cycloplegic agent are of value in the diagnosis of incipient glaucoma.

Light Sense. Waite, Derby and Kirk⁴⁰ suggest that the light sense in early glaucoma is affected before there is any sustained increase in intraocular tension, any cupping of the disk or any visual field changes characteristic of glaucoma. This disturbance in light sense is characterized by: (1) a tardiness of dark adaptation, and (2) in the dark adapted eye, a dulling of sensitivity to dim light.

Medical Treatment. Numerous medical measures have been recommended for the treatment of glaucoma. The administration of adrenal cortex extract in glaucoma has been investigated by Woods⁴¹ who does not advise its therapeutic use in glaucoma.

Surgery. New surgical technics for the treatment of glaucoma are numerous. Barkan⁴² devised a method of opening Schlemm's canal by employing the binocular microscope for certain cases of chronic glaucoma. Schoenberg⁴³ has also recommended the use of a binocular microscope for delicate surgery of the eye.

Wootton, in 1932,⁴⁴ and Wheeler,⁴⁵ in 1936, devised technics which combined iridectomy with cyclodialysis for the reduction of ocular tension.

Verhoeff⁴⁶ advocated a button-hole iridectomy, midway between the pupil and the attached border; in this technic the upper border of the buttonhole is seized and drawn under the conjunctival flap, turning the pigmented surface forward and leaving the sphincter iridis within the eye.

Gifford⁴⁷ advises iridencleisis with water tight closure of the conjunctiva because of its effectiveness in reducing tension permanently in the large majority of cases. Its chief value is in chronic simple glaucoma and buphthalmos. Greenwood⁴⁸ believes that a well performed combination of iridencleisis and sclerectomy will almost invariably yield a good filtering cicatrix and usually without massage in chronic glaucoma.

Reese⁴⁹ described a conjunctival flap for glaucoma, using a broad keratome, while a pocket flap sclerecto-iridodialysis for glaucoma has been described by Spratt.⁵⁰

After studying postoperative glaucoma, Fox⁵¹ believes that the obstruction at the filtration angle is the ultimate cause of all postoperative glaucoma.

EYEBALL

Exophthalmos. Much valuable work on progressive exophthalmos has been done by Naffziger.⁵² He has advised⁵³ the intracranial removal of the orbital plate and the roof of the optic foramen, and the opening of the ring of Zinn. It has recently been shown that space can be found for the excessive orbital contents by opening downward into the antrum instead of upward into the cranial cavity and with greater safety.

In pulsating exophthalmos, Dorrance⁵⁴ has ligated the common carotid and, after a week or two, all of its branches except the internal maxillary and the superficial temporal branches from the external carotid.

Enucleation and Evisceration. In 1900, Gifford⁵⁵ strongly advocated simple evisceration. Because the ball placed in the sclera in Mules' operation was extruded in many cases, Fox⁵⁶ tenotomized the four recti muscles immediately after the removal of the contents of the eyeball.

CONJUNCTIVA

Conjunctivitis. John E. Weeks⁵⁷ was the first to demonstrate that a small bacillus (usually known as the Koch-Weeks bacillus) was the etiologic factor in acute contagious conjunctivitis. Verhoeff⁵⁸ discovered the filamentous organism classified as leptothrix which causes Parinaud's conjunctivitis. He also demonstrated the characteristic histology of these lesions.

A new form or type of conjunctivitis named "agricultural conjunctivitis" has apparently been established by Gifford and Patton,⁵⁹ the bacteriologic findings being a mixed infection with a gram-positive anaerobic bacillus as the dominant micro-organism.

According to Woods,⁶⁰ allergic conjunctivitis may be caused by pollens, food, animal dusts, inhalants or bacterial toxins

and proteins. Clinical and experimental data suggest that vernal catarrh is an allergic disturbance. Radium for the treat-

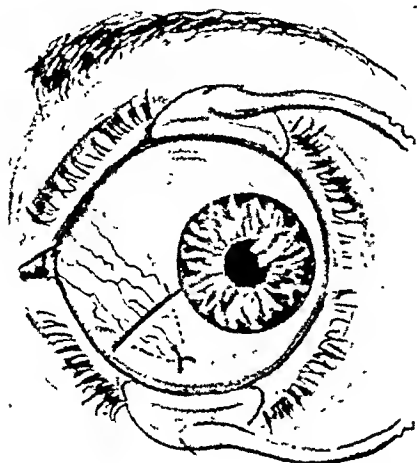


FIG. 1. Transplantation for pterygium.
(From McReynolds, J. O. The nature and treatment of pterygia. *Tr. Sect. Ophth., A. M. A.*, p. 47, 1902.)

ment of vernal conjunctivitis has been employed by Quick.⁶¹

Thygeson⁶² has employed staphylococcus toxoid to immunize patients with conjunctivitis, presumably due to toxigenic staphylococci. His results suggest that further clinical trial of staphylococcus toxoid is required. Studies on the action of staphylococcus toxin and antitoxin with special reference to ophthalmology have been reported by Burky.⁶³

Trachoma. Although Noguchi did not discover the cause of trachoma, he did clarify our knowledge of follicular conjunctivitis by finding the *Bacillus granulosis*. In 1934, Thygeson⁶⁴ studied the nature of the elementary and initial bodies of trachoma and later⁶⁵ discussed the filtrability of the trachoma virus.

In investigating the infectivity of trachoma, Julianelle and Harrison⁶⁶ stated that antigenically, the infectious agent of trachoma appears to be ineffectual, since it stimulates neither antibody formation nor increased resistance during active infection.

The treatment of trachoma has apparently been revolutionized by the use of

sulfanilamide. In 1939, Gradle⁶⁷ presented a review of the problem. Successful results have been reported by numerous investigators.⁶⁸ Sulfanilamide apparently has a rapid effect on the secondary infections associated with trachoma.

According to Thygeson,⁶⁹ sulfanilamide appears to be most efficacious in early cases of trachoma and when employed in relatively high dosages. However, healing has been obtained in certain longstanding cicatricial cases and in some cases in which low doses were given over a relatively long period of time.

Inclusion Blepharrrhea. Thygeson⁷⁰ has stated that the etiologic agent of inclusion blepharrrhea is a filtrable virus having an elementary body phase and an initial body phase. According to Julianelle and Lange,⁷¹ diagnosis may be verified by the presence of cytoplasmic inclusions of the epithelial cells, which may be observed extracellularly.

Gonorrheal Ophthalmia. Fernandez and Fernandez⁷² report that in a series of patients with gonorrheal ophthalmia, who received sulfanilamide, all recovered in a spectacular manner and in a shorter period of time than that required by other accepted forms of treatment. The treatment of gonorrheal ophthalmia by means of sulfanilamide has also been advanced by Bower and Frank.⁷³

Surgery. In 1899, May⁷⁴ performed an operation for symblepharon in which he constructed a new cul-de-sac, using a large Thiersch graft. For total symblepharon, Weeks⁷⁵ employed a Wolffian graft, which he applied to a plate of hard rubber and placed in the orbit after canthotomy.

In 1902, McReynolds⁷⁶ devised a modification of transplantation for the correction of pterygium. (Fig. 1.) He emphasized the fact that there should be no incision along the upper border of the pterygium.

Gifford⁷⁷ found that the best results in pseudopterygium follow a free dissection of the scar tissue from the cornea and the placing of a Thiersch graft of skin on the raw surface.

In 1891, Knapp's roller forceps operation for trachoma,⁷⁸ which has been a valuable contribution to the surgical treatment of trachoma, was first described.

In cases in which the ocular conjunctiva is markedly diseased, as in trachoma and even in other ocular diseases, Denig⁷⁹ recommends that the diseased tissue should be replaced by strips of mucous membrane taken from the mouth and sutured into position on the eyeball.

EYELIDS

Surgery. If the association of blepharochalasis with the development of the endocrine glands can be substantiated, Benedict⁸⁰ believes that it is probable that some medical treatment can be applied for relief during the intumescent stages but that excision of the redundant skin is the only successful treatment.

Wheeler,⁸¹ in 1920, published his original and modified blepharoplastic procedures which were the results of experiences in the last World War. The use of the orbicularis palpebrarum muscle in congenital absence of the external canthal ligament has been described by Wheeler.⁸² H. and S. Gifford⁸³ slightly modified Machek's useful modification of the Panas operation for ptosis; Reese⁸⁴ used orbicularis strips instead of skin which he sutured to the occipitofrontalis. Lancaster, in 1919, showed that fascia lata could be advantageously used to connect the frontalis and the upper eyelid.

An operation for the correction of spastic entropion by attaching a strip of orbicularis to the orbital margin has been described by Wheeler.⁸⁵ Hughes⁸⁶ has described a method of rebuilding the lower eyelid which is similar to the technic employed by Dupuy-Dutemps,⁸⁷ except that the former uses the remaining tissue of the lower eyelid instead of a skin flap from the upper eyelid. The upper eyelid is split into two layers transversely. The inner layer composed of the tarsus with the levator attached to its upper border is pulled down and attached to the conjunctiva in the lower fornix. The skin of the cheek is undermined, pulled up

and united to the anterior surface of the tarsus.

CORNEA

Keratitis. Although the exact etiology of keratitis bullosa is unknown and treatment is usually unsatisfactory, Davis⁸⁸ has reported a case of keratitis bullosa which responded well to x-ray treatment and Pfeiffer⁸⁹ has successfully used Grenz rays. According to Green,⁹⁰ the surgical removal of Bowman's membrane in two cases of bullous keratitis permitted permanent adhesion of newly formed epithelium to the substantia propria. Green's results seem to support the theory that the essential cause of bullous keratitis is a disease or alteration of Bowman's membrane.⁹¹

After a study of 225 patients with dendritic keratitis, Gundersen⁹² concluded that the application of a strong solution of iodine is the most effective known treatment because it destroys the virus infected corneal epithelium.

According to Johnson and Eckardt,⁹³ rosacea keratitis may be the direct result of deficiency of riboflavin, which is one of the factors in vitamin B₂ complex.

In 1935, Beetham,⁹⁴ in treating patients suffering from filamentary keratitis (keratoconjunctivitis sicca), advocated destruction of the canaliculi in an effort to utilize the small amount of lacrimal secretion, which is characteristic of this disease. In 1925, Verhoeff⁹⁵ stated that this lesion is essentially an exposure keratitis, arising when there is a deficiency of lacrimal secretion. The importance of the seventh nerve in the innervation of this gland is pointed out; as well as the fact that this nerve may be injured in Gasserian ganglion operations. He also showed that blood transfusion from a donor who had recovered from, and was therefore immune to herpes zoster had marked curative value in herpes zoster ophthalmicus.

Walker and Walker⁹⁶ have used diphtheria antitoxin in the treatment of acute and chronic herpes zoster ophthalmicus. This treatment has been most successful

in their cases. In 1919, Key⁹⁷ advocated the use of antidiaphtheritic serum in hypopyon keratitis and other severe ocular infections.

Kayser-Fleischer Ring. The Kayser-Fleischer ring (Wilson's disease) has been discussed by Goldbach⁹⁹ who reported three cases of hepatolenticular sclerosis. He believes that the features of this disease indicate a toxic agent. As the disease is probably hereditary, the conclusion by analogy would be that it is based on a primary disturbance of metabolism.

Surgerv. In 1899, Baker¹⁰⁰ introduced a technic of keratoplasty employing a "shirt-stud" shaped transparent glass which he attached after excising the opaque cornea. In 1930, Key¹⁰¹ attempted total transplantation. He dissected a circumcorneal area of conjunctiva for a distance of 4 mm. and then completed the section of the cornea with a large keratome and cataract knife.

In 1934, Castroviejo¹⁰² advised excising a square area of opaque cornea using a new double bladed knife and transplanting healthy cornea, which he completely covered by two conjunctival flaps. He¹⁰³ had some success in grafting a rectangular fragment into a leukomatous cornea. In 1926, Wiener¹⁰⁴ advised the resection of corneal opacities.

The ball cautery, devised by Wadsworth for the treatment of corneal ulcers, was modified by Todd¹⁰⁵ in 1908; he used a copper ball with a platinum point.

In 1918, Gifford¹⁰⁶ described the technic of delimiting keratotomy, which has proved of great value in treating corneal ulcers. Hypotony is produced by incising the cornea, tangent to the border of the ulcer. Wiener¹⁰⁷ suggests "a safer method," involving the same principle of penetrating the cornea beyond the border of the ulcer, emerging on the opposite side, and then turning the blade of the knife forward with a single sweep.

Whenever signs of increased tension develop in association with corneal ulcers, Weeks¹⁰⁸ advocated opening the anterior chamber. Several valuable operations have

been suggested for the treatment of conical cornea, and Wiener¹⁰⁹ combined peripheral iridectomy with excision of the upper peripheral part of the cornea. The operation described by Green and Green¹¹⁰ combines canthoplasty, iridectomy and then excision of a crescent-shaped area of sclera. Transplantation of the cornea has been successful.

LENS

Allergy and Immunology. That allergic inflammation of the eye "endophthalmitis phacoanaphylactica" might result from hypersensitiveness to lens protein was first suggested by Verhoeff and Lemoine.¹¹¹

According to Woods and Burky,¹¹² the experimental production of cataracts by immunologic procedures is a controversial subject. They state that after rupture of the lens capsule a certain percentage of individuals may develop a cutaneous hypersensitivity to lens protein, the only apparent source of which is their own lens which presumably acts as the sensitizing antigen. These investigators believe that the fully developed lens capsule is probably impermeable to antibodies.

Davis¹¹³ has claimed that by the therapeutic injection of lens antigen, the progress of immature cataract could be retarded or checked and formed opacities could be liquefied and absorbed by cytolytic action. Although this work has not been completely substantiated, lens antigen may act as a nonspecific agent in raising resistance. The production of hereditary anomalies of the eye in relation to the use of lens antigen and uveal pigment has been discussed by Davis and Smith.¹¹⁴ The study of hereditary eye anomalies is important because 49 per cent of the children in schools for the blind in the United States for the school year 1937 to 1938 were classified as blind from prenatal causes.

Permeability of Capsule. After studying the permeability of the lens capsule, Friedenwald¹¹⁵ concluded that its permeability is qualitatively the same in vivo as in vitro, and that the capsule is permeable to

all electrolytes and true solutes in water, as well as to small and medium sized colloidal particles. In these experiments, normal lenses, kept in sterile salt solution at body temperature, became cataractous if food-stuffs were not supplied and metabolic products not removed. Such cataracts resemble, both on slit lamp and histologic examination, spontaneous senile cortical cataracts.

Cataract Caused by Drugs. Certain drugs recently employed have been blamed for the production of cataract. Numerous cases of cataract following dinitrophenol treatment for obesity have been reported,¹¹⁶ as well as a few cases of cataract following the administration of dinitrocresol. Experimentally this has not been proved.¹¹⁷ Cataract following sulfanilamide therapy of iridocyclitis in a patient with latent gonorrhea has been reported by Van Lint and Alaerts.¹¹⁸

Chemistry of Lens. The capsule contains less total nitrogen and more aminonitrogen than the other lens proteins. According to Krause,¹¹⁹ the large amount of carbohydrate in the capsule suggests that it is related to the mucoprotein of the lens.

Hektoen¹²⁰ has shown that the alpha and beta crystallins were precipitogenically distinct. A method of obtaining almost pure preparations of both the alpha and beta bodies, so that they react only to their own antibodies, has recently been perfected by Burky and Woods.¹²¹ These authors¹²² also reported the isolation of a third protein which they have called gamma crystallin.

In 1911, Clapp¹²³ demonstrated the presence of a substance which changed the insoluble albuminoid of the lens to a soluble compound which he believed to be a proteolytic ferment. Burge¹²⁴ was able to estimate not only the amount of ash in normal human adult lenses, but also the amount of potassium.

It has been shown by Tassman and Karr¹²⁵ that in normal pig's lens, glutathione was present in 0.296 per cent and that a definite ratio was established be-

tween cystein and cystine of 0.296/0.704 or 0.420. It was also determined that glutathione was entirely absent in cataractous lenses.

According to Verhoeff,¹²⁶ crystals found in coralliform cataract are protein in nature and this is probably the first instance of protein crystals observed in the body.

Medical Treatment. In discussing the medical treatment of cataract, Greenwood¹²⁷ stated that the nonoperative treatment may be divided into four varieties: (1) hygienic; (2) local applications; (3) electricity, radium and x-ray, and (4) lens antigen. Greenwood advises the hygienic treatment and the intermittent use of dionin. He also believes an improvement in vision and a retarding of the progression is more likely, if coincident with the use of dionin treatment, there is an improvement in the general condition, with an elimination of all foci of infection or abnormal blood states. No treatment is of value according to Kirby.¹²⁸ The relation of avitaminosis to the etiology of cataract has aroused much interest. Langston, Day and Cosgrove¹²⁹ have studied the production of cataract and other ocular changes in albino mice by the administration of a vitamin G deficient diet. Cataract appeared in 96 per cent after an average of forty-eight days on the deficient diet, and ophthalmia in 57 per cent after fifty days.

Operations on the Lens. Apparently Williams,¹³⁰ of Boston, was the first to describe the use of a suture in cataract operations. Many modifications of Williams' technic have been proposed. Several methods to ensure accurate adjustment of the lips of the wound after tying the sutures have been devised by Verhoeff.¹³¹ He has described a special instrument for the insertion of corneoscleroconjunctival sutures in cataract operations.¹³² Blake¹³³ has devised a conjunctival flap holder for cataract sutures. A scleroconjunctival suture was described by Derby.¹³⁴ Recently, McLean¹³⁵ developed a new type of corneoscleral suture; a small groove is made beneath the conjunctival flap with the

Lundsgaard knife. Lancaster, in 1940, devised a special knife for this purpose. The suture is placed through the scleral and

Reese¹⁴⁴ believes that radiation cataract is particularly suitable for intracapsular extraction because of the proliferation of

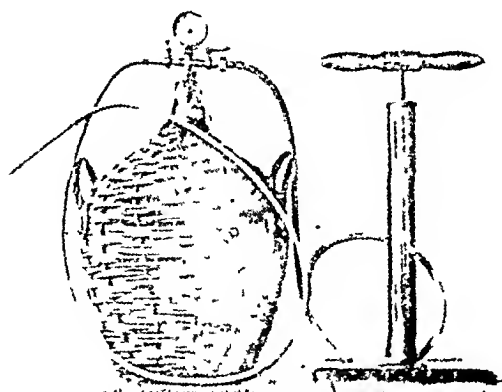


FIG. 2. Vard Hulen apparatus for the intracapsular extraction of cataract. (From American Encyclopedia of Ophthalmology, 3: 1549, 1914, Chicago, Cleveland Press.)

corneal lips of the groove before the section is made.

Ellett¹³⁶ has done a great deal to popularize the use of sutures and especially the Kalt suture; he has lived to see most of the ophthalmic surgeons in the United States of America using some form of suture in cataract operations.

In 1900, Herman Knapp¹³⁷ introduced his method of opening the capsule by a peripheric incision. Homer Smith¹³⁸ and Wandless¹³⁹ both advocated division of the capsule as a preliminary step to the removal of the cataract, especially but not solely, in cataracts which are immature.

In 1902, the cataract incision was modified by Wilson and Miles¹⁴⁰ in order to make a flap of conjunctiva adhering to the cornea.

Americans have done much to advance the intracapsular method of extracting the lens. In 1913, Knapp¹⁴¹ suggested a method by which he partially luxated the lens by means of capsule forceps, after performing iridectomy, and expressed it in its capsule. The Stanculeanu-Knapp-Torok method¹⁴² has been advocated by many surgeons, and Knapp's method¹⁴³ of traction with expression after iridectomy has been a great factor in popularizing the intracapsular extraction.

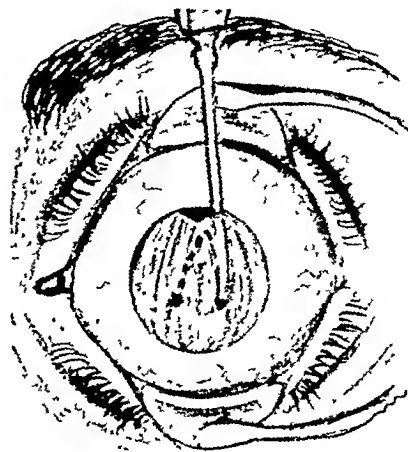


FIG. 3. Complete discission of the lens by the V-shaped method. (From Ziegler, S. L. Complete discission of the lens by the V-shaped method. *J. A. M. A.*, 77: 1101, 1921.)

the epithelium under the anterior capsule into a metaplastic fibrous layer.

The first satisfactory suction cup instrument for intracapsular extraction of cataract was devised by Hulen.¹⁴⁵ (Fig. 2.) Dimitry¹⁴⁶ has recently evolved a new syringe type of suction apparatus, which is proving practical. Green¹⁴⁷ has devised a modification of the Barraquer apparatus.

Much attention has been given to methods of incising secondary membranes; and in 1898, Herman Knapp¹⁴⁸ stated that the opening must be made by cutting and not by tearing. He devised knife-needles with a cutting edge much longer than that of an ordinary cataract needle. Ziegler¹⁴⁹ also designed a special knife-needle with a very fine point, a straight cutting edge 7 mm. in length, and a round shank of sufficient size to block the opening and prevent the escape of the aqueous humor. He advocated an inverted v incision. No mention of complete discission of the lens by an incision anterior to the iris apparently appears in the literature prior to Ziegler's publication of his practical method of making an inverted v incision through the anterior and posterior capsule with his discission knife.¹⁵⁰ (Fig. 3.)

In secondary cataract, Wheeler¹⁵¹ advocated a single straight incision across the iris muscle fibers using a special knife in order to make an artificial pupil. D. W. Hunter had previously employed a ground-down Graefe knife for the same purpose.

The removal of soft lenses and dislocated lenses has been facilitated by the development of the Hildreth ultraviolet lamp.¹⁵²

In 1915, Verhoeff¹⁵³ recommended scleral punctures for subchoroidal hemorrhage following cataract extraction or sclerotomy and also for persistent cases of choroidal detachment. Verhoeff was the first to save an eye following intraocular hemorrhage and in 1931, Samuels¹⁵⁴ explained the method of handling this complication.

According to O'Brien,¹⁵⁵ detachment of the choroid after cataract extraction occurs almost invariably at the time of operation. For cataract extraction, O'Brien¹⁵⁶ advises a method of paralyzing the temporofacial branch of the seventh nerve as it lies in the upper part of the parotid glands. In the extraction of cataract, avertin anesthesia has been advocated by Davis¹⁵⁷ and panto-cain by Wilmer and Paton.¹⁵⁸

In 1921, Bell¹⁵⁹ introduced his method of preventing postoperative intraocular infections by instilling two drops of a 1 per cent solution of silver nitrate into each eye.

OPERATIONS ON THE LACRIMAL APPARATUS

One of the most outstanding advances in ophthalmic surgery is dacryocystorhinostomy in place of excision of the lacrimal sac. Prior to West's operation, intranasal operations involved the removal of a part of the inferior turbinate. West¹⁶⁰ advocated a window resection of the lacrimal duct above the inferior turbinate, leaving this structure intact. In 1902, Buller¹⁶¹ ligated the canaliculi to isolate an inflamed lacrimal sac from the conjunctiva. Subconjunctival section of the ductules of the accessory lacrimal gland for excessive lacrimation has been described by Jameson.¹⁶²

RETINA

Retinitis. In 1892, Knapp¹⁶³ described the formation of dark angioid streaks as an

unusual metamorphosis of retinal hemorrhage. In 1928, Verhoeff¹⁶⁴ stated that the cause of the fibrosis in angioid streaks is obscure but that the most probable one may be a slowly progressive vascular obstruction limited to the affected area. In 1937, Benedict¹⁶⁵ studied the pathology of angioid streaks.

In 1927, Wagener¹⁶⁶ described a new type of retinitis associated with malignant hypertension. His important studies have established a distinction between retinal angiosclerosis of purely local origin and one which suggests general vascular involvement.

Holloway's and Verhoeff's clinical and pathologic researches¹⁶⁷ have advanced the knowledge of the histopathology of gross macular disorders.

Tumors. A classification of tumors of the glioma group on a histogenetic basis with a correlated study of prognosis was made by Bailey and Cushing.¹⁶⁸ Martin and Reese¹⁶⁹ have successfully treated certain cases of retinal glioma by means of the fractionated or divided dose principle of roentgen radiation.

Retinal Blood Vessels. H. Friedenwald¹⁷⁰ and Preston were apparently the first Americans to report accurate ophthalmoscopic examinations of patients with general arteriosclerosis. In 1896, Friedenwald¹⁷¹ published a paper on the significance of constrictions and dilations of the caliber of the retinal arteries in arteriosclerosis. In 1930, further studies¹⁷² were published by him.

It has been shown¹⁷³ that in subjects examined to determine the influence of posture on retinal blood pressure, a marked increase in retinal diastolic pressure was noted as the subject changed from the standing to the prone position. Repeated study of the blood pressure in the central artery apparently aids in the establishment of an early diagnosis of increased intracranial pressure in the absence of papilledema.

Puntenney¹⁷⁴ reports that the only measurable effect of lowering the intraocular

pressure with the Kukan apparatus¹⁷⁵ was a slight dilatation of the retinal veins. In the experiments in which amyl nitrite, mecholyl, epinephrine, nembital, hyperpyrexia and cold pressor tests were studied measurable dilation of the veins was recorded in several cases with mecholyl. Lambert¹⁷⁶ has described a method for studying the retinal circulation of animals so that the size of the vessel at any point can be determined in microns.

In studying retinal perivascular delineation, Evans¹⁷⁷ found prussian blue particles about the vessels and cells. He states that it must not be assumed that they are in a formed space, in an anatomic sense, or that their passage from vitreous to retinal and nerve spaces indicates the rate or direction of normal fluid flow.

Chemistry. Important and fundamental advances in regard to the chemical changes which follow the incidence of visible light upon the retina have been made by Hecht.¹⁷⁸ He demonstrated that the initial reaction in the visual process is a simple photochemical one. Moreover, he showed that light adaptation is accompanied by the diminution, and dark adaptation by the accumulation of the photochemical substance in the retina.

Mathematically, Venable¹⁷⁹ has shown that the absorption of light by the visual purple and the subsequent energy interchanges, affecting this substance, can be interpreted as occurring in quanta. According to Venable, color sensation is ascribable to the number of synchronous discharges involved, two, three or six of these being liberated or absorbed at the same time.

The sedimentation constant of visual purple has been studied by Hecht and Pickels.¹⁸⁰ Hecht¹⁸¹ has also investigated the rods, cones and the chemical basis of vision.

Valuable work on the carotenoids and the visual cycle has been done by Wald.¹⁸² In recent years, night blindness and similar visual disturbances, associated with the nutritional state of the body, have been traced to vitamin A contained in the diet.

The chemical relation between vitamin A and the light sensitive pigments of the retina has also been studied by Wald.

After studying the metabolism of the retina, Adler¹⁸³ concluded that the low concentration of sugar in the vitreous is due to the high rate of glycolysis of the normal retina.

Operations on the Retina. A simple needle for the diathermy treatment of retinal detachment has been designed by Gradle.¹⁸⁴ A technic of treating the flat type of separated retina and of macular holes with special applications and a compact diathermy and electrolysis apparatus has been devised by Walker.¹⁸⁵ He has also advocated the use of very slanting punctures made with a "beading needle" and reaching for a distance of 2 to 3 mm. between the sclera and choroid.¹⁸⁶

AQUEOUS CIRCULATION

The rate of flow of the aqueous circulation has been studied by Friedenwald and Pierce.¹⁸⁸ They concluded that there exists a continuous through and through circulation of aqueous solution within the eye. These investigators¹⁸⁹ in studying the mechanism of reabsorption of the aqueous humor concluded that the reabsorption occurs almost exclusively from the anterior chamber.

Knowledge of the anastomoses and anatomic relations of Schlemm's canal have been added to by Theobald,^{189a} who found the collector channels to be more numerous than is ordinarily believed. (Fig. 4.)

In a study of the posterior outflow of fluids from the eye,¹⁸⁷ it was found that part of the material injected gained access to the perivascular regions of the central vessels of the optic nerve in the eye of the rabbit and in one normal human eye; no stain was found around the central vessels in four pathologic human eyes, the eyes of dogs or guinea pigs.

OPTIC NERVE

Electrical Responses. The electrical responses accompanying activity of the optic

pathway have been studied by Bishop.¹⁹⁰ He showed that the action currents of the optic cortex and retina differ from those of

abnormal proliferation of the normal adult types of neuroglia of the nerve system. Tumors of the optic nerve, in Davis'

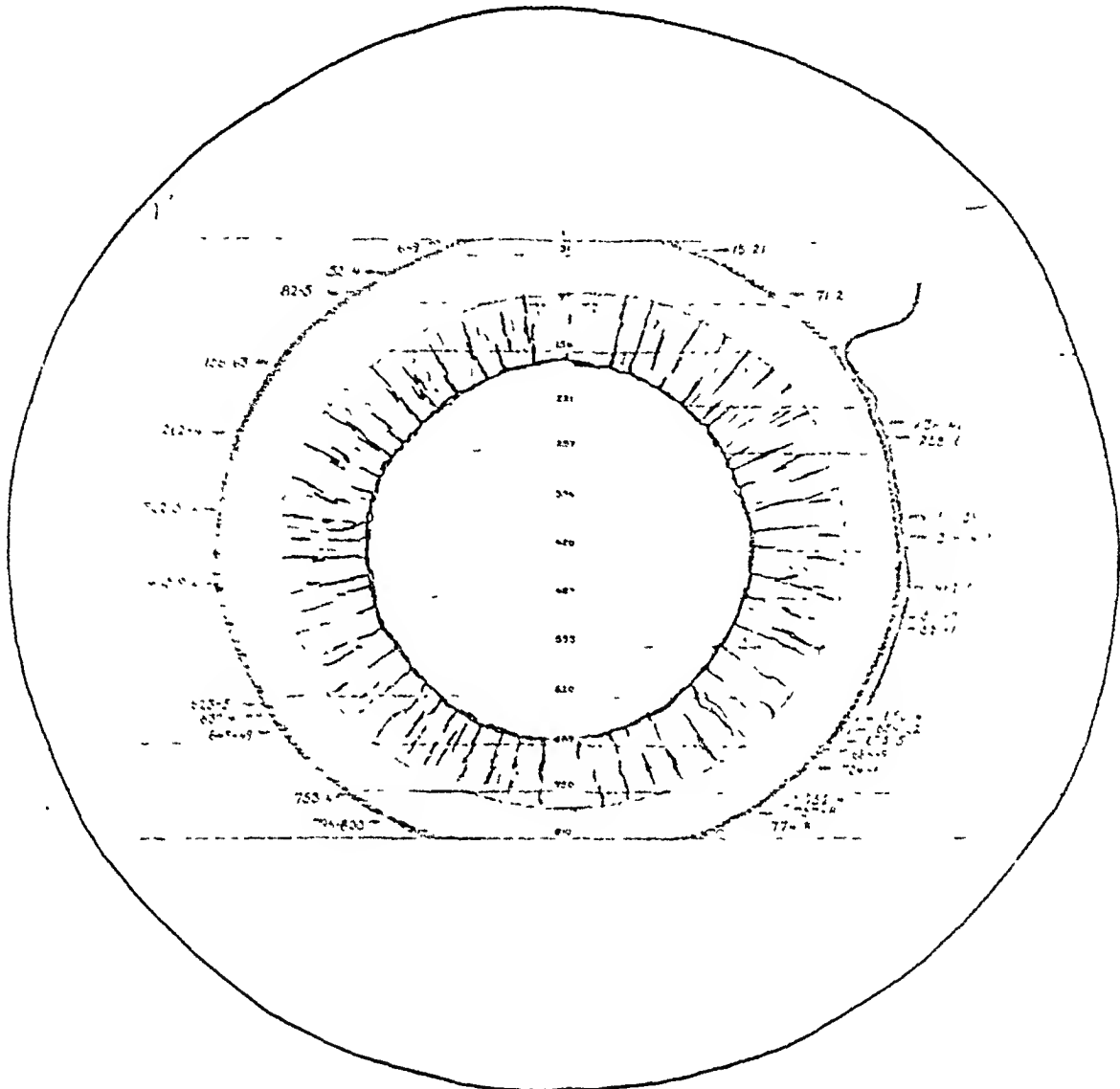


FIG. 4. Reconstructed from 810 serial sections. The space between the horizontal lines represents 1 mm. No. 420 is the center section. Illustration shows: (1) Twenty-nine collector channels leaving the canal of Schlemm at irregular intervals. They are most numerous in the lower temporal quadrant, where there are as many as 5 to 1 mm. At No. 460 to 623, and T. 72 to 236, the space between is more than 2 mm. (2) A large artery is shown joining the canal of Schlemm at Section 159, and running along intimately with it for more than 8 mm. (From Theobald, G. D. Schlemm's canal its anastomosis and anatomic relations. *Tr. Am. Ophth. Soc.*, 32: 5-1, 1934.)

the peripheral nerves in being of longer duration and of different form.

Tumors. Verhoeff's investigation of tumors of the optic nerve¹⁹¹ resulted in a demonstration that the most usual growth is glioma. Martin and Cushing¹⁹² have added to the knowledge of primary gliomas of the chiasm and optic nerves. According to Davis,¹⁹³ glial tumors start with an

opinion, are usually a part of a more widely disseminated lesion of the peripheral and central nervous systems, commonly referred to as neurofibromatosis or Recklinghausen's disease.

Early diagnosis by ophthalmologists of meningiomas arising from the tuberculum sellae has been urged by Cushing and Eisenhardt.¹⁹⁴ The syndrome of failing

vision, primary optic atrophy and bi-temporal field defects combined with a normal sella turcica encountered in middle-aged persons should lead to early operation.

Toxic Amblyopia. The first description of a case of blindness caused by methyl alcohol in the United States was reported by J. M. Ray.¹⁹⁵ In 1914, Tyson and Schoenberg¹⁹⁶ revealed that methyl alcohol in the eye produces a toxic edema of the tissues, which with the increased viscosity of the blood, interferes with its free circulation.

The important analysis of 153 cases of blindness and 122 deaths attributable to methyl alcohol by Wood and Buller¹⁹⁷ and Ziegler's report¹⁹⁸ in 1921 served as a warning concerning the serious complications associated with methyl alcohol even in small quantities, by inhalation and even by absorption through the cutaneous tissues¹⁹⁹ and as a beverage or an adulterant.

When a toxic neuritis, associated with tobacco or alcohol exists, a careful study frequently reveals that both drugs are active. In the studies of de Schweinitz and Edsall²⁰⁰ a chemical analysis of the secretions from the urine demonstrated the presence of enterogenous decomposition products in the subjects with amblyopia caused by tobacco and rapid improvement when normal metabolism was restored.

In 1937, Carroll²⁰¹ studied eight patients with tobacco-alcohol amblyopia. After hospitalizing this group, he permitted them to continue to smoke and drink as much as they had while contracting the disease. However, he placed them on a high vitamin B well balanced diet. All but one patient showed satisfactory results and obtained vision for reading. The speed of recovery seemed to be at least as good in these patients as in patients, previously studied, who abstained from tobacco and alcohol.²⁰²

The first effort to produce amblyopia experimentally with quinine in this country dates from 1890 when a series of researches by de Schweinitz²⁰³ demonstrated that toxic doses of quinine in dogs produced a replica of the picture of the fundus in

human beings, atrophy of the nerves, optic tracts and chiasm. Holden's experiments²⁰⁴ in 1898 indicated that quinine is a direct poison to the retinal ganglion cells, which causes the ascending degeneration of the optic nerve, chiasm and optic tracts.

Optic Atrophy Associated with Syphilis. The subdural treatment of syphilitic primary optic atrophy, according to Moore and his associates,²⁰⁵ produces permanent arrest of optic atrophy in about half of the patients adequately treated. However, there is a risk of sudden loss of vision in about 10 per cent of cases.

Papilledema. Parker²⁰⁶ has shown that the edema of the nerve head is usually greater in the eye with the lower tension. Papilledema did not occur in dogs with the benign type of experimental hypertension examined by Keyes and Goldblatt²⁰⁷ as long as the excretory function of the kidney remained normal. Decreased renal excretory power was usually followed by ocular changes characterized by edema and detachment of the retina, papilledema and hemorrhages.

VITREOUS BODY

Holloway studied²⁰⁸ asteroid hyalitis "snow-ball opacities" and synchysis scintillans. Friedenwald and Stiehler²⁰⁹ believe that the vitreous body consists of a solid framework composed mainly of very thin, concentrically arranged sheets. They state that the spaces between the sheets are filled with a viscous fluid.

MOTOR ANOMALIES

The terms exophoria, esophoria, hyperphoria and cyclophoria were introduced by G. Price and Giles Savage²¹⁰ in the last decade of the nineteenth century. Stevens²¹¹ was one of the first to classify motor anomalies. In 1897, Duane²¹² published a new classification of motor anomalies of the eye which greatly clarified the subject.

Lucien Howe's systematic contribution²¹³ to the study of ocular muscles is invaluable. Lancaster has made valuable additions to the mechanism of muscular action²¹⁴ and

to diagnosis.²¹⁵ Through his book²¹⁶ and his numerous publications,²¹⁷ Peter has added to our knowledge of many important problems. The studies of White^{217a} and Dunnington^{217b} have clarified our knowledge of motor anomalies.

Anisophoria. Anisophoria has been defined by Friedenwald²¹⁸ as that form of heterophoria in which the degree of muscular imbalance varies with the direction of gaze. He points out that anisophoria may be produced by the correction of anisometropia with ordinary spectacle lenses as well as by the unequal action of the extraocular muscles.

Orthoptic Training. Guibor²¹⁹ has contributed valuable data on orthoptic training. The importance of orthoptic treatment combined with surgery of the ocular muscles is now gradually being accepted. The role of the orthoptic technician as an aid to ophthalmologists has been emphasized by J. E. Lancaster.²²⁰ These technicians are now assuming an important place in the treatment of motor anomalies.

Fusional Movements. One of the most interesting results shown by Burian's experiments on fusional movements²²¹ is that peripheral retinal stimuli are strong enough to break the fusion of images situated on corresponding areas of the macular region, provided they cover a sufficient area.

Anomalous Retinal Correspondence. Much is still to be learned concerning anomalous retinal correspondence. According to Burri,²²² the classic assumption that the two retinas correspond exactly by either a cell or a retina to cortical area relationship has no neurologic proof so far, beyond the discovery of a certain topographic arrangement of the retina in the cortical centers. Burri believes that knowledge points toward a dynamic plasticity rather than toward a static anatomic relationship. Verhoeff²²³ has studied anomalous projection and other visual phenomena associated with strabismus.

Stereopsis. Wells²²⁴ has made an outstanding contribution to the use of the

stereoscope in ophthalmology. The study of depth perception has been advanced by the Howard modification of the Brooks Bank James apparatus^{224a} which is used extensively for studying stereopsis.

Accommodation. There have been several valuable additions to our knowledge of accommodation during the last fifty years. The world is indebted to Duane²²⁵ and Jackson²²⁶ for their excellent studies on the amplitude of accommodation at various ages which added to the original work of Donders. Also Duane's studies of binocular accommodation as contrasted with monocular accommodation demonstrate that as a rule with both eyes the near point of accommodation is closer to the eyes than with each eye separately and that this difference lessens somewhat with increasing age. We are also indebted to Duane²²⁷ for his excellent classification of anomalies of accommodation.

Although there is still much controversy concerning the mechanism of accommodation, the fine work of Luedde²²⁸ points more toward the Tscherning theory. Ferree and Rand²²⁹ through their apparatus (tachistoscope) for studying inertia of adjustment of accommodation have added much to our knowledge of this subject. In their studies published in 1918, the time required for eighteen normal observers to pass from near to far varied between 0.50 and 1.16 seconds, a range of 132 per cent, and from far to near between 0.39 and 0.82 seconds, or a range of 110.3 per cent. In 1939, Ferree and Rand described a multiple-exposure electrical tachistoscope.

Cogan's²³⁰ brilliant researches have clarified the mechanism of adjusting the eyes for distant vision.

There is no doubt that accommodation is an important factor in asthenopia as originally pointed out by Donders; the development of the ophthalmic ergograph for the study of accommodation and convergence²³¹ and Howe's and Lancaster's studies²³² of fatigue of accommodation have been of great importance in the study and treatment of patients who

complain of ocular fatigue during close work.

Operations on the Ocular Muscles. In

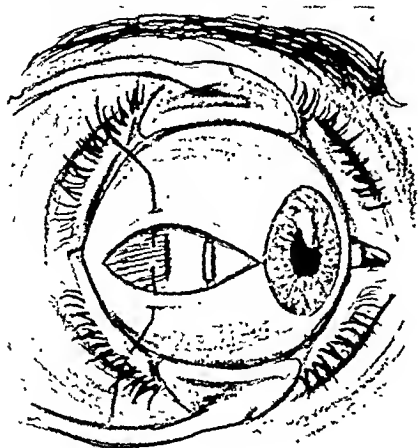


FIG. 5. Curdy recession operation. Suture is introduced before tendon is divided.

1889, Stevens²³³ recommended a modification of Critchett's operation for those cases of heterophoria which cannot be sufficiently corrected by tenotomy.

Jackson²³⁴ suggested that it would be possible to overcome the disturbance due to paresis of the superior oblique, at least to some extent, by operation of the superior rectus. Extraocular tendon lengthening and shortening operations which permit the surgeon to regulate the effect were advocated by Todd.²³⁵

The technics for resection most widely used in this country are those of Reese,²³⁶ Lancaster²³⁷ and Wilkinson.²³⁸ The recession operation on the medial rectus was first performed by Curdy²³⁹ (Fig. 5); his technic was modified by Jameson,²⁴⁰ Agatston²⁴¹ and other surgeons.

For shortening tendons, O'Connor proposed the popular cinch operation²⁴² which was devised to eliminate strain on the stitches after advancement operations. In 1917, Jackson²⁴³ reported that he had performed transplantation of the superior oblique on cadaver eyes in order to prevent extreme divergence.

An operation on the superior oblique to use it as an internal rotator in third nerve paralysis has been performed by Peter.²⁴⁴

Superior oblique and inferior oblique advancement operations were devised by Wheeler.²⁴⁵ Graduated tenotomy of the inferior oblique muscle as an aid in the correction of certain forms of squint has been advocated by McCool.²⁴⁶

In 1917, Woodruff²⁴⁷ performed partial tendon transplantation of the vertical recti muscles in two cases of paralytic convergence. Key²⁴⁸ advocated transplantation of the temporal half of the vertical recti tendons in cases of complete paralysis of the external rectus. Transplantation of portions of the vertical recti tendons to strips of the external rectus tendon was performed by O'Connor.²⁴⁹ He²⁵⁰ has also devised three methods of transplanting the ocular tendons.

EXAMINATION OF THE EYE

Several advances in instruments and methods of examination have been made in this country. Of a number of tonometers designed the most used are those of McLean²⁵¹ and Gradle.²⁵²

Ferree and Rand²⁵³ have made valuable contributions to the testing of visual acuity. Among the factors they have discussed are the sensitive use of the test for the detection of errors of refraction, the comparative merits of test objects and a new type of test object consisting of a broken circle.

Light Sense. Ferree and Rand²⁵⁵ have also devised an instrument for testing light and color sense. A few instruments have been designed for the study of dark adaptation. The Feldman apparatus²⁵⁶ is useful for the qualitative study of dark adaptation. An excellent adaptometer for measuring human dark adaptation has been designed by Hecht and Shlaer.²⁵⁷ Ferree and Rand have devised an attachment for the Ferree-Rand perimeter for measuring light and color minima.²⁵⁸

Crampton²⁵⁹ was the first to utilize a battery handle for the electric ophthalmoscope. A "U" shaped mirror for the ophthalmoscope was made by Marple.²⁶⁰ The May ophthalmoscope is another practical advance in the examination of the

eye; it is useful not only for ophthalmoscopy but also for external examination by the use of the slit beam.

In 1924, Friedenwald²⁶¹ described a freely movable instrument for monochromatic ophthalmoscopy with yellow-green light. A year later, he discussed visibility of the retinal capillaries with yellow-green light.²⁶² In 1929, Friedenwald published his clinical studies on slit-lamp ophthalmoscopy.²⁶³ In 1932, he described a new ophthalmoscope,²⁶⁴ which was devised to make possible the adaptation of principles of slit-lamp microscopy to the examination of the eye ground and posterior vitreous body. Evans²⁶⁵ also described slit-lamp ophthalmoscopy. Dobson²⁶⁶ has described the examination of the fundus oculi by light of limited spectral range.

The atlas²⁶⁷ published by Bedell and his numerous monographs have enriched the literature and advanced the science of ophthalmoscopy.

Gonioscopy. Troncoso²⁶⁸ devised the gonioscope for the examination of the angle of the anterior chamber, which has been especially useful in determining the need for glaucoma operations.

Retinoscopy. Jackson²⁶⁹ developed the technic of retinoscopy with the plane mirror and he²⁷⁰ was the first to describe the crossed cylinder. In 1890, Jackson discussed retinal illumination²⁷¹ and in 1895, the first edition of his volume on skiascopy was published.²⁷² His method of objectively measuring the power of accommodation appeared in 1905.²⁷³

Transillumination. Transillumination of the eye is another important development; Würdemann²⁷⁴ was one of the early originators of this form of examination.

Foreign Bodies. Sweet's method of localization of foreign bodies in the eyeball with roentgen rays²⁷⁵ and Dixon's modification²⁷⁶ have been outstanding contributions.

Muscles. Stevens has made important contributions to the examination of the ocular muscles. The Stevens tropometer and phorometer²⁷⁷ aid in the more accurate diagnosis of motor anomalies.

One of the most accurate methods of testing for cyclophoria is the clinoscope.²⁷⁸ Jackson²⁷⁹ has suggested fusion tubes for the diagnosis and treatment of cyclophoria. An ingenious spectacle for the nonoperative treatment of cyclophoria has been developed by Ames²⁸⁰ and Lancaster.²⁸¹ Ames' methods of measuring cyclofusional amplitude, cyclophoria and cyclotropia are distinct advances in the diagnosis of motor anomalies.

Perimetry and Campimetry. Important developments in perimetry in this country have been made possible through the greater use of the tangent screen, improved illumination, development of better test objects and more knowledge concerning the physiology of vision. Walker has added greatly to the subject of quantitative perimetry, especially in his work with Cushing²⁸² in the field of neuro-ophthalmology. The work of these authors has given ophthalmology a new insight into the symptomatology of tumors in the temporosphenoidal lobe by pointing out the localizing importance of partial or quadrant defects of the visual fields. These authors have also enriched our knowledge of various changes observed in pathology in the pituitary region, and the work of de Schweinitz and Schaeffer²⁸³ has clarified the underlying anatomy. More recently, Elsberg²⁸⁴ and his associates have studied the relation of the nervous system and the brain to visual phenomena. In 1937, in evaluating quantitative visual tests for localization of supratentorial tumors of the brain they stated that their visual tests, although they did not reveal the anatomic structures involved in tumors of the brain, did demonstrate the disturbances of function caused by these new growths.

Through the painstaking work of Evans²⁸⁵ the importance of angioscotometry has been greatly increased. He has made important contributions in the field of glaucoma, retinal edema and quinine amblyopia; more recently it appears that he may have suggested a means of determining the early signs of pregnancy, by

showing that there is a scotoma above the blind spot in women who are about to menstruate which is apparently not present when they are pregnant.

Through the development of scientific apparatus and technics, Ferree and Rand²⁸⁶ have added greatly to our knowledge concerning the normal visual fields in different refractive errors and some pathologic conditions. The Ferree-Rand perimeter is an outstanding development in ophthalmology. The Lloyd stereocampimeter improved on the study of the central visual field in certain cases by facilitating binocular fixation.

PHOTOGRAPHY OF THE EYE

Bedell has done much to popularize the use of photography in studying and illustrating internal conditions of the eye.²⁸⁷ According to Mann,²⁸⁸ the practical utilization of infra-red photography in ophthalmologic practice seems limited to the visualization of the anterior portion of the eyeball, especially in cases of corneal opacities, in which no other means of examination will reveal abnormalities of the iris and pupil.

Stereoscopic photography is increasing in importance because many pathologic details may be recorded which could not be illustrated in a single picture. Redway²⁸⁹ has stressed the importance of color photography for improved teaching of ophthalmology. In 1929, he²⁹⁰ published a simplified technic for instantaneous color photography of the living human eye.

REFRACTION

Refractor. One of the new instruments, which is of value in refraction, is the Leland refractor,²⁹¹ which utilizes polarized light. The advantages are not only that it is a sensitive test for the axis and amount of astigmatism but also an instrument which permits a balancing of the spherical correction as well as adjustment of the axis of the cylinders in binocular vision. In cases of muscular imbalance the instrument indicates the spherical changes re-

quired or, if prisms are indicated, the proper amount.

Aniseikonia. Ames and his associates²⁹² have developed the ophthalmoeikonometer and special lenses for the study and correction of aniseikonia. The correction of the difference in size of images has been a factor in relieving asthenopic symptoms in certain patients. Induced size effect has been studied by Ogle²⁹³ with restricted fusion stimuli and in relation to asymmetric convergence.

Lenses. Many new forms of bifocals have been designed for special purposes.²⁹⁴ Hardened ophthalmic lenses are also being used.²⁹⁵ Olsho²⁹⁶ has described thin lenses and bifocals for high myopia. New plastic materials are now used²⁹⁷ for grinding shatter proof lenses.

Telescopic Lenses. Feinbloom²⁹⁸ has developed new types of telescopic lenses. Berliner²⁹⁹ has developed a new type of spectacle consisting of a fused telescope. Bettman and McNair³⁰⁰ have constructed a spectacle with a contact lens-telescopic system, which permits an unrestricted field of vision.

Contact Lenses. The power and magnification properties of contact lenses have been investigated by Boeder.³⁰¹ Numerous aids in fitting contact lenses have been developed.³⁰² Feinbloom²⁹⁸ designed a plastic contact lens. Contact lenses with spheric optic and aspheric haptic parts have been described by Nelson.³⁰³ The fitting of contact lenses for patients with ametropia has been discussed by Obrig.³⁰⁴ Stevens³⁰⁵ in 1936, developed a method of making casts of the human cornea in fitting contact lenses. Contact lenses made from molds have been described by Obrig.³⁰⁶

ILLUMINATION

Improved illumination as a result of the development of the incandescent bulb has been a factor in facilitating ophthalmologic examination. Artificial daylight illumination was developed to a high point by Macbeth.

Ferree and Rand have made many valuable contributions to the use of illumination in examining the eyes.³⁰⁷ In 1928, Hecht³⁰⁸ studied the relation between visual acuity and illumination. Lancaster³⁰⁹ has been outstanding in his investigations of light, especially in relation to ophthalmologic patients.

Most complete studies of illumination have been made by Luckiesh and Moss.³¹⁰ In their book, "The New Science of Seeing," they report numerous experiments concerning the effect of illumination on experimental subjects, e.g., pulse rate and metabolism. McFarland³¹¹ has also contributed to the study of illumination in relation to pulse rate and metabolism.

TREATMENT

Radiant Energy. The pathologic effects of radiant energy on the eye were described by Verhoeff and Bell in 1916.³¹²

The treatment of diseases of the eye with Grenz rays has been discussed by Pfeiffer.⁸⁹ He contends that Grenz rays are as efficacious in the treatment of superficial lesions of the eye as any other form of radiant energy and that they do not have the disadvantages of similar therapies.

Shahan³¹³ devised the thermophore with which the degree of heat can be exactly determined in treating ulcers, tumors and retinal detachment.

Vitamins. Yudkin³¹⁴ has made valuable contributions to the study of vitamins in the treatment and prevention of ocular diseases.

Vaccine. Howard,³¹⁵ in 1928, described the intravenous use of typhoid-paratyphoid vaccine in diseases of the eye. In the hands of Brown³¹⁶ the use of typhoid H antigen before intraocular operations has proved valuable.

Transfusion. The role of transfusion in ophthalmology has been stressed by Frey³¹⁷ who states that transfusion is a splendid nonspecific therapeutic reinforcement.

Tuberculosis. Gay³¹⁸ has made valuable contributions to the treatment of ocular tuberculosis with tuberculin. Rich,³¹⁹ in

1929, showed that in ocular tuberculosis "while allergy was truly responsible for the destructive, inflammatory caseating and necrosing phases of the tuberculous lesion, immunity was a totally separate process."

AVIATION OPHTHALMOLOGY

Aviation medicine made rapid strides in the last World War. Numerous phases of the reaction of the eyes to altitude and flying stress have been studied. Wilmer and his associates³²⁰ demonstrated that low oxygen tension and not low barometric pressure was the cause of decreased ocular function at high altitude.

CONCLUSION

This résumé of some of the more important advances made by American ophthalmologists in the past fifty years has been limited in scope because of space. However, sufficient material has been presented to demonstrate the broad field that has been covered by investigators in this country and to show that substantial advances have been made in most of the subdivisions of ophthalmology. No doubt the present World War is interfering greatly with the advance of ophthalmology in other countries, except possibly in so far as plastic surgery is concerned. This places a heavier burden on ophthalmologists in the United States to advance the knowledge of this important field of work.

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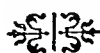
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FIFTY YEARS OF OTOLARYNGOLOGY

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FIFTY years ago otolaryngology was in its infancy. During the latter part of the nineteenth century Politzer, the nestor of the otolaryngological profession, was in Vienna. Sir Felix Semon developed laryngology in England. In this country, among others, Blake was advancing otology and Bosworth rhinolaryngology.

At that time otolaryngology occupied a very insignificant place in the curricula of our medical schools. There was in medical schools little or no cooperation between the departments of medicine, surgery, pediatrics and otolaryngology. Perhaps the greatest advance during the past fifty years has been the intimate contact that has developed in our medical schools between the other clinical departments and otolaryngology. This, together with the realization that otolaryngology is only a subdivision of medicine and surgery and cannot make progress independent of these, has had much to do with the development of this specialty. Today anatomy, pathology surgery, medicine and pediatrics constitute the foundation for otolaryngology.

Undergraduate courses in this subject have become much better. Fewer hours are devoted to the subject than fifty years ago but the time is much better utilized. Fifty years ago the undergraduate course had as its object to teach the student to treat patients with otolaryngological disorders. The small number of specialists, the sparsely settled communities, with poor roads and the country doctor, necessitated this.

Today the principal function of the undergraduate course is to prepare the student for otolaryngological work during his undergraduate ward service and particularly to form a foundation for his work during his general internship.

The exigencies of the situation have been met by the great increase in qualified otolaryngologists, increase in population, hard surfaced roads, the automobile and county hospitals.

The graduate work in otolaryngology in this country fifty years ago was mediocre. At that time Vienna was the mecca for graduate students from the United States and Great Britain. There were a few graduate courses in otolaryngology in America, where the whole subject was taught in a few weeks. In England there was abundant opportunity to work in out-clinics but there was little systematized teaching, and there were very few residencies.

After the World War the American Otolological, Rhinological and Laryngological Society appointed a committee to study undergraduate and graduate teaching of otolaryngology. This committee functioned for a number of years and aided very much in the development of otolaryngology. The American Academy of Ophthalmology and Otolaryngology established a teachers' section. This met once a year. All important otolaryngological teaching problems were debated. This section still exists, the attendance is large and it has helped and is still helping in the development of the undergraduate and graduate teaching of this subject.

The greatest influence on the development of otolaryngology was, and now is, the American Board of Otolaryngology. It was created in the early part of the twenties. Its initial membership consisted of two members from the American Otolological Society, two from the American Laryngological Association, two from the American Academy of Ophthalmology and Otolaryngology, and two from the Ear, Nose and

Throat Section of the American Medical Association. All members serve on the board without remuneration and all are outstanding teachers of otolaryngology. The purpose of the board is to certificate those otolaryngologists who in their judgment are good otolaryngologists. The certificate indicates to the medical profession and the public the proficiency of the holder of the certificate. In order to determine this examinations are held at least twice a year.

A careful study of the credentials of each candidate is made before he is admitted to examination. The examination is divided into four parts; clinical, written, didactic and pathological.

All hospitals with residencies in otolaryngology and all medical schools with graduate courses in otolaryngology have been unconsciously stimulated by the work of the Board and are making efforts to see that their graduates not only meet the requirements of the Board but also pass the examinations. The Board has been an important factor in the development of graduate teaching of otolaryngology. Over two hundred candidates are examined yearly.

Due to the work of the American Board, the hospitals and medical schools, the graduate teaching of otolaryngology in the United States has become the best in the world. Courses in the basic sciences of otolaryngology are given. The purpose of these courses is to prepare the individual for a residency in otolaryngology. In some instances the hospital staff gives to its residents courses in the basic sciences. The otolaryngologists who are educated today are well trained. Fifty years ago we had to travel and to work hard both at home and abroad to secure training which was far inferior to that given in all parts of the United States today.

Research work in otolaryngology in this country is the very best. Mosher, Crow, Proetz, Fenton, Bunch, Schall, Furstenberg, Fowler, Hilding and a host of others are aiding in its advance.

The advances in medical education and the research work have made a wonderful change in otolaryngology in fifty years. Fifty years ago many physicians were general practitioners today, otolaryngologists tomorrow. The change was indicated by a new sign hung over the door or printed on the window. Many of these physicians were sprayers of the nose, a procedure which has been almost wholly discarded.

The surgery of otolaryngology was not developed. Acute suppurative mastoids were drained only if the condition of the patient was critical. I know of one prominent surgeon in a State Medical Society Meeting defending the use of boric drops in the ear over a long period for chronic suppurative otitis media, rather than drainage of the purulent pocket.

Surgery of the ear, nose and throat developed during the early part of the last fifty years. Much of the groundwork for surgery was laid by Zuckerkundl's work in the anatomy of the nasal sinuses. This was done during the last part of the nineteenth century. The work of Onodi, particularly on the nasal sinuses in children, in 1908, was an important factor. Sir St. Clair Thomson contributed to laryngology throughout the past fifty years.

In 1913, Kerrison produced a Textbook of Otology. This was the best one published in English up to that time. This had much to do with the advance in surgery of the ear.

Shambaugh, with his work on the anatomy of the ear, contributed much to aural surgery.

Barany did much to improve our knowledge of labyrinthine conditions.

The radical operation for chronic suppurative otitis media was introduced in this country. Unfortunately in the beginning it was done too often, both in this country and abroad. Surgery of the ear and nasal sinuses was too radical during the first twenty-five years of this century. At this time far more conservative procedures are in vogue. An understanding of allergic sinusitis has prevented many operations.

Among others Mosher, Jackson and Sluder have had much to do with the development of otolaryngology in America during the past fifty years. Mosher, the rhinological anatomist and clinician, was responsible for many new surgical procedures on the nose, nasal sinuses and neck. Sluder, the physiologist, clarified the subject of nasal headaches. Jonathan Wright made great strides in otolaryngological pathology. Jackson, the technician, perfected instruments and technic that made bronchoscopy and esophagoscopy so easy that the majority of laryngologists become proficient in this field.

It is impossible to mention even the outstanding otolaryngologists of America during the last fifty years. Dwyer brought the intubation tube into general use, saving innumerable lives. Allergic study of patients, diatetic treatment, outdoor exercise and the use of vaccines produced satisfactory results in many otolaryngological cases without resorting to operation.

The work of Proetz and Hilding has had a nihilistic effect on the use of drugs and sprays in the nose. The treatment of nose, throat and ear disease fifty years ago was more or less empirical; today it is based on a sound physiologic and pathologic basis.

Otologists during the last fifty years were not content to develop the pure clinical side of the subject but they made great progress in the management of the deafened child and the correction of speech defects.

Itard, in 1802, made the first scientifically logical accomplishment in the field of auditory stimulation for the improvement of hearing in the deafened child with a remnant of hearing. Toynbee followed in the footsteps of Itard. Currier, in New York, and Gillespie, at the Nebraska School for the Deaf, developed this educational procedure during the latter part of the nineteenth century.

In 1893, Urbantschitsch made auricular training practical. Vienna was at that time the center for graduate teaching of otology and many of us worked with Urbantschitsch. I can remember returning to my clinic and interesting one of the graduate students in this subject. She selected a boy twelve years of age, supposed to be deaf, and using Urbantschitsch's technic developed in the boy sufficient hearing to permit him to enter the public school.

Dr. Max Goldstein worked with Urbantschitsch. With the founding of the Central Institute for the Deaf in St. Louis in 1914, he became active in the developing of acoustic exercises for the deaf. He has been largely responsible for the development of the science of re-education of the deaf in this country.

Hudson Makuen, Goldstein and others developed the science of the correction of speech defects. Otolaryngologists during the past fifty years have done much in the rehabilitation of the handicapped child.



FIFTY YEARS OF THORACIC SURGERY*

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ANESTHESIA, asepsis and antisepsis gave the surgery of fifty years ago a firm foundation upon which to build. Thoracic surgery, of course, shared in the stimulus these three great discoveries gave to experimental and clinical surgery but the advance of thoracic surgery was necessarily held in abeyance until roentgenology was discovered in 1895 and, to a less extent, until bronchoscopy, esophagoscopy, thoracoscopy, bronchography and respiration under differential pressure were still later made available.

These tools are now used almost daily in every active thoracic surgery clinic and are rightly considered as indispensable. While reading many case histories of fifty years ago, I was constantly aware of the overwhelming difficulties the clinicians of that time faced in attempting to determine the nature, size and exact position of intrathoracic lesions without the use of roentgenology and bronchoscopy; and it is not surprising that the scope of thoracic surgery was then greatly limited and that the clinical results were shockingly bad when judged by present-day standards. The difficulty of exact localization of a small or even medium-sized pulmonary abscess for surgical drainage by physical signs alone, without the aid of roentgenology, is apparent to the innumerable surgeons who have experienced difficulty in localizing small abscesses even with the combined use of physical signs, x-ray and bronchoscopy. The problems presented in an attempt to remove an intrabronchial foreign body without the aid of bronchoscopy or roentgenology may readily be appreciated.

So great were the obstacles to progress from the groping thoracic operations of fifty years ago that DeForest Willard, an

American, wrote of "the extreme inherent difficulties and dangers which must be met in our attempts to invade the thorax," and Taeufert, a German, asserted that surgeons were well aware that most operations in the chest, perhaps with the exception of empyema operations, will give only limited results, while Stephen Paget, an Englishman, introduced a book, "The Surgery of the Chest," which he published in 1896, by saying that the time was ripe for the presentation of the valuable facts he had collected "because there are signs that we have reached a stage in this portion of our art beyond which, on our present lines, we cannot advance much further." Manning wrote in 1894, "The lungs were among the last [internal organs] to receive systematic treatment by operations" and he added that such operations were few, having followed experiments on animals or having been undertaken as a last resort in incurable cases. Only William LeMoyne Wills, professor of descriptive and surgical anatomy at the University of Southern California, among the authors whose writings of fifty years ago I have read, expressed an optimistic opinion about the future development of thoracic surgery, predicting that with improvements in surgical methods the successful partial lobectomies he carried out experimentally on animals would, within ten years, be justifiable in man and that they would be as successful as ovariectomy, when performed by competent surgeons.

It is of interest that fifty years ago (1890) David W. Cheever published an article, "Old and New Surgery," in the Boston Medical and Surgical Journal, in which he discussed with justifiable satisfaction the great surgical progress that had been made

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during the preceding fifty years. He spoke with gratitude of the boon of anesthesia and antisepsis, which had been introduced during that fifty-year period, and of their enabling a surgeon to operate without haste and without fear of the terrible consequences of a gravely infected wound. He pointed out the frequency with which pyemia, phlebitis, erysipelas and prolonged wound suppuration followed the operations of that earlier period, the frequent necessity of amputation for infected compound fractures, and the use of a stab incision for the division of a constricting hernial ring because of the virtual certainty that an open dissection would cause suppuration.

The tremendous progress that has been made in thoracic surgery during the last fifty years is indicated by the limited scope of the surgery of the chest at the beginning of this period and the fact that now virtually every disease affecting the chest has been successfully operated upon. When the American Journal of Surgery was established fifty years ago thoracic surgery was limited to the treatment of injuries, pleural and pericardial empyema, necrosis of bone, abscess of the lung, neoplasms of the thoracic wall, drainage of tuberculous cavities and hydatid cysts, dilatation of esophageal strictures and the removal of intrabronchial foreign bodies.

The advances that have been made during the last fifty years in the whole field of the medical sciences have been of particular service to thoracic surgery, enabling it to solve problems that had scarcely been seriously considered fifty years ago. The results of treatment of every surgical disease of the chest have been vastly improved during this fifty-year period. Only did the management of empyema begin to approximate the modern treatment of this condition.

EMPYEMA

The articles published in 1890 and 1891 reveal a strong body of opinion opposed to the then recently prevalent practice of not interfering with an empyema, in the hope

that spontaneous absorption of the pus would occur, and an almost equally strong body of opinion opposed to the indefinitely prolonged needle aspiration of pus.

Although the diagnosis of empyema was largely based upon the auscultatory and other well known methods of physical examination, several physicians published pleas for the frequent early use of exploratory needle aspiration as a diagnostic measure in doubtful cases, rightly reasoning that early diagnosis and the early institution of adequate treatment would greatly improve the end results. Goggans, an American, cited his own experience of 168 aspirations of the pleural cavity for a variety of purposes, without ill effect. He aspirated one empyema seventy-three times before he realized that tube drainage was necessary!

As long as fifty years ago several surgeons recognized the fundamentally important fact that needle aspiration of the pleural fluid during the early days of an empyema gave time for the formation of firm pleural adhesions at the limits of an empyema cavity that had been reduced in size by the aspirations. When surgical drainage was carried out after these adhesions had formed, only a localized abscess cavity, not the entire free pleural cavity, was opened. Early drainage of an infected free pleural cavity is notoriously dangerous and is likely to lead to chronic empyema. These sound principles were largely lost sight of until they were firmly established on experimental grounds and well publicized at the time of the World War by the Empyema Commission of the United States Army, of which Commission Evarts A. Graham was the chairman.

In the early 1890's, as in 1940, there was little agreement as to the best type of surgical drainage and, incidentally, there was much discussion as to whether antiseptic irrigations were valuable or dangerous. A few surgeons advocated only intercostal incision. In this country many advocated the use of a tube in an intercostal incision, while abroad the majority of surgeons pre-

ferred the resection of a part of a rib followed by tube drainage. In Germany there was strong support of Bulau's water-seal tube drainage through an intercostal incision, although some surgeons complained of the frequency with which the small tube became occluded by fibrin and débris. One surgeon held open a drainage wound with hooks that were kept taut by an attached rubber tube passed around the chest.

In order to determine the lower posterior limit of an empyema, Kuster made a small anterior incision through which he probed the cavity for the best site for dependent drainage, but the simpler method of determination of this site by aspiration was already known, as was the fact that a postoperative elevation of the diaphragm might occlude a drainage tube that had been placed too low.

With regard to the treatment of tuberculous effusions and empyemas there was no unanimity of opinion and no conception of the fact that different types of empyema required different forms of treatment. Chronic tuberculous and nontuberculous empyema was often well handled by an Estlander or Schede type of thoracoplasty if prolonged adequate drainage had failed to bring about a cure.

Although certain writers of fifty years ago understood some of the principles of treatment of empyema, only Rickman Godlee of England, among the authors I have read, seems to have understood the disease so well that he managed his cases of empyema much as we do today. We now recognize the importance of early diagnosis, and of aspiration until firm adhesions have formed which localize the pleural abscess. We then resect a portion of a rib at the bottom of the empyema cavity, usually in the posterior axillary line, and make an incision through the bed of the rib only large enough to admit snugly a tube as wide as one's thumb, the outer end of this tube being placed beneath water in a jar. If this air-tight, negative-pressure type of drainage does not soon cause expansion of the lung and complete obliteration of the

cavity, an increase in the negative pressure by means of a pump is likely to do so.

PULMONARY ABSCESS

The difficulties involved in distinguishing pulmonary abscess from bronchiectasis or empyema with bronchopleural fistula, and in exactly localizing an abscess, before x-rays were available, as well as the relatively primitive surgical technic used, made the surgical treatment of pulmonary abscess very unpopular. Among those surgeons who collected the records of the known cases of surgical drainage, Runeberg, a German, found the largest number—forty. Fewer than half of these patients were cured or improved. Willard found the outcome had been successful in six of thirty collected cases; Slawyd found three recoveries among thirteen cases and Seitz four among nineteen. Gaston wrote in 1890 that there were thirty-six cases on record and that "When S. Seabury Jones encountered his first case nine years ago, he was unable to find any reference to the subject whatever in any of the text books. His second case was observed in 1886."

The effect of the difficulty in exactly localizing an abscess was to postpone drainage until the patient had become septic or until the abscess had become so large that it could be readily localized by aspiration. At this time the prognosis was obviously bad in a great majority of the cases. Localization and drainage of secondary abscesses were rarely, if ever, undertaken. Godlee stated that (in such late cases) surgical drainage produced improvement only to a certain point and that hemorrhage, cerebral abscess or other complications might then occur, or that the patient would have to use a drainage tube indefinitely.

Godlee recognized the danger that a diagnostic aspiration might cause an empyema if pleural adhesions were not complete at the site of the aspiration. He recommended the suturing of the lung to the thoracic wall if adhesions were not found at the time of operation.

The technic of drainage was variously performed. With or without the resection of a part of a rib, needle aspiration was followed by the introduction of a scalpel, trocar or other instrument into the abscess. A tube was then introduced into the abscess, perhaps after enlargement of the track with a finger or forceps.

Probably the greatest advance made during the last fifty years in the treatment of pulmonary abscess was the accuracy of diagnosis and localization made possible by x-rays. This accuracy has increased to the present time with the widening appreciation of the value of lateral and oblique, as well as postero-anterior, projections of the x-rays that has occurred. Bronchoscopy has made an important contribution to the determination of the segment of the lung occupied by the abscess, and in the detection of foreign bodies, bronchial neoplasms and other forms of bronchial occlusion, which are not rare etiologic agents.

Bronchoscopy and postural drainage have proved successful in the nonsurgical treatment of a small group of patients and, through the teaching of Neuhof, increasing recognition has been granted to the value of very early surgical drainage of a pulmonary abscess in which a brief trial of nonsurgical measures has failed. Accurate localization makes possible adequate drainage after the removal of a short segment of only one rib and, as pleural adhesions are often present where the abscess is most superficial, a one-stage operation is often possible. These recent advances in diagnostic methods and surgical technic have improved the results of treatment tremendously.

PULMONARY TUBERCULOSIS

Fifty years ago the treatment of pulmonary tuberculosis was fumbling and wholly inadequate. The sanatorium principle had been proposed but not widely adopted. Koch had recently discovered the tubercle bacillus and there was great enthusiasm over the possibility of a cure of the disease with tuberculin. Inhalations

of chlorine gas, insufflations of chloride of gold and sodium and subcutaneous injections of iodoform or creosote were variously tried. Weak solutions of tincture of iodine, carbolic acid, silver nitrate, corrosive sublimate, salycilic acid and other chemicals were injected directly into tuberculous lungs, or into tuberculous cavities after aspiration of their contents. Some physicians found such treatment useless, while others found occasional symptomatic improvement.

Mosler, in Germany, and de Cérenville, in Switzerland, revived an interest in the surgical drainage of tuberculous cavities but, apart from a few cases of symptomatic improvement, the results proved to be disappointing. During the last few years relatively good results have been obtained from drainage (by direct incision or by a catheter introduced by means of a trocar and cannula) of certain types of cavity, particularly that in which the draining bronchus has become obstructed.

During the last fifty years the greatest advances in the treatment of pulmonary tuberculosis have been through the universal adoption of collapse therapy and of the sanatorium, and through efforts to supply a sufficient number of sanatorium beds to meet the demand for them. Although Forlanini's first publication recommending pneumothorax appeared in 1882, and de Cérenville's report of his first "relaxing thoracoplasties" appeared in 1885, an active interest in collapse therapy did not arise until approximately thirty years ago. The first extensive thoracoplasty, that of Brauer and Friedrich, was performed in 1907; the improved Wilms-Sauerbruch modification was introduced in 1911; the modern type of thoracoplasty was not performed until 1928.

Open thoracotomy for the division of offending pleural adhesions in cases of pneumothorax was proposed by Friedrich in 1908, and the operation of closed intrapleural pneumonolysis by means of a thoracoscope was introduced by Jacobaeus in 1913. Paralysis of the diaphragm

through operations on the phrenic nerve was introduced by Stuerz in 1911. Tuffier, in 1893, performed an extrapleural pneumothorax operation, which was sporadically repeated by others until the operation was revived without enthusiasm by Nissen in 1931, and with enthusiasm by Monaldi in 1933. The extrapleural separation of the lung from the thoracic wall and the filling of the space created between them with gauze was carried out by Sarfert in 1901; Tuffier used a filling of a free fat graft in 1910 and Baer used a paraffin mixture in 1913.

A sound knowledge of the effect of these operations upon the different types of tuberculous lesions was acquired slowly, as was a proper evaluation of the inter-relationship between the different operations, and their usefulness or limitation in the management of bilateral lesions. Only during the last ten or twelve years has collapse therapy been used in the leading sanatoria of the world with a full appreciation of its value and limitations, and with the production of astonishingly good results. The number of patients so treated has been too small, in relation to the total number of patients treated for tuberculosis, greatly to affect the tuberculosis death rate. It is probable that the death rate will be greatly reduced when all sanatoria use collapse therapy with maximal efficiency.

THORACIC WALL NEOPLASMS

Operations on thoracic wall neoplasms were performed rather frequently fifty years ago. Little mention was made of benign lesions and, apparently, most were sarcomas. The successful removal of some huge tumors of the ribs or sternum was reported, as well as a considerable number of surgically fatal cases. Among the articles of that period, I note that the surgeons often used an open drainage tube in the thoracic wall after an operation that opened the pleural cavity for an uninfected lesion, and I suppose that some of the deaths were due to a "sucking pneumothorax" that resulted from the presence of

the tube. A better understanding of thoracic physiology has led to the tight closure of such wounds or, if drainage should be necessary, to the use of an airtight, water-seal drainage system. The greatly improved results that have been produced in recent years in the treatment of neoplasms of the thoracic wall have been due not only to the technical improvement just mentioned but to the early diagnoses and operations that the universal use of the roentgen rays has favored.

INTRATHORACIC NEOPLASMS

The difficulty of diagnosis of intrathoracic neoplasms before the first clinical use of the roentgen rays in 1896, and of bronchoscopy and esophagoscopy still later, had the effect of making the surgical treatment of such lesions relatively rare. Diagnosis depended upon the clinical history, physical signs and needle aspiration. The material recovered by aspiration, whether solid or fluid, might lead to a diagnosis. Little was published about neoplastic tumors of the lung and mediastinum and there was a general feeling that the great majority were either sarcomas or carcinomas, for which surgical success would be only a matter of luck, and the only routine treatment for which was the aspiration of a complicating pleural effusion. The drainage of an occasional dermoid cyst was reported and, incidentally, hydatid cysts were operated upon with relative frequency. About fifty years ago Phillips collected 138 cases of hydatid cyst of which thirteen were operated upon with nine recoveries and four deaths; he found that almost all those not operated upon, or merely aspirated, died.

In an 1892 issue of the British Medical Journal, Rickman Godlee wrote as follows: "Amongst a good many cases of cancer of the lung or mediastinum, I have never yet met with one that at all suggested the possibility of removal by operation. Such operations have, however, been suggested, but the circumstances under which there can be even a chance of success must be

exceedingly rare; and thus—although, in animals, portions of lung may be ligatured off and removed without producing any very serious symptoms, I do not think this is at all a promising branch of surgery” and, in 1894, J. A. Manning wrote, “Tumors, which are so eagerly attacked everywhere else, are respected when they involve the lung, save only those with fluid contents.” In 1883, however, Kröenlein successfully removed a portion of a lung containing a walnut-sized recurrent sarcoma six months after having resected the huge primary tumor from the thoracic wall, and in 1891 Tuffier successfully resected the apical portion of a man’s lung for a tuberculous lesion. Several indirect references were made during this period to the successful removal of the traumatically herniated portion of a lung. William LeMoyné Wills, of Los Angeles, learned from W. W. Keen, Roswell Park, Senn and Fenger in 1892 that none of them had ever removed a part of a lung, except in cases of traumatic pulmonary herniation, abscess “or similar condition.”

A number of surgeons occupied themselves fifty years ago with the experimental removal of portions of a lung. Bogliano, Patek and Sailer, of Philadelphia, undertook to remove whole lobes from dogs but the animals died from gangrene of the stump and empyema. They succeeded, however, in three partial lobectomies and one total lobectomy by drawing the part of the lung to be resected out of the chest through a very short intercostal incision and suturing the stump of the resected part in the intercostal incision. Tuffier’s experiment, reported in 1891, is especially noteworthy. In a dog he resected two-thirds of the superior lobe of the right lung and six days later one-third of the superior lobe of the left lung, suturing the stumps into the incisions in the intercostal muscles. He killed the dog seventeen days after the first operation and found complete pleural adhesions around the right-sided stump and complete, but less well organized, adhesions on the left side; no pneumothorax re-

mained, the thorax being completely filled by the remaining portions of the lungs.

At approximately the same time Quenu and Hartmann proposed, on the basis of human cadaver experiments, the paravertebral resection of two-centimeter lengths of the third, fourth and fifth ribs as affording a better surgical approach to lesions in the dome of the thorax than the usually proposed infraclavicular incision. Although this incision had not then been used in man, it has been rediscovered a number of times during the last fifty years. A still greater contribution to the future successful surgical management of intrathoracic neoplasms and other conditions, was the report by Tuffier and Hallion, in 1896, of their animal experiments in preventing collapse of the lung by the use of chloroform insufflation through an intratracheal tube introduced through the larynx. They found that this procedure enabled them to operate on the esophagus, vagus and sympathetic nerves and other intrathoracic structures without upsetting the pulmonary circulation. This discovery is one of the vitally important foundations upon which the successes of modern thoracic surgery have been built, and yet it was not put to clinical use until many years later.

The first successful removal of an entire lobe of a lung in man was accomplished by Körte in 1907. The patient was suffering from bronchiectasis; Körte first removed the right lower lobe and, as pulmonary secretions continued, later removed a part of the right middle lobe and the patient made a complete recovery from his disease. Another dramatic advance was made in 1931 when Nissen, of Berlin, successfully removed an entire bronchiectatic lung; the second successful total pneumonectomy was that of Cameron Haight, of Ann Arbor, in 1932. The following year Evarts Graham was the first successfully to remove an entire lung for carcinoma; the patient is now, more than seven years after the operation, well and free from any evidence of recurrence. Graham’s successful case represented the first curative treatment of

cancer of the lung in the history of medicine and during the last seven years has hugely stimulated an interest in the early diagnosis of cancer of the lung.

While the removal of benign and malignant neoplasms of the lung and mediastinum was a great rarity fifty years ago, it is a commonplace occurrence today in active thoracic surgery clinics, where the mortality rate is surprisingly low and the percentage of cures high. Such an advance has been made possible by the use of diagnostic roentgen rays, endoscopy, differential pressure anesthesia and, importantly, a proper appreciation of thoracic physiology in relation to the preoperative, operative and postoperative care of patients requiring large intrathoracic operations.

HEART AND PERICARDIUM

Fifty years ago a number of successful cases of aspiration of, or drainage of, effusions or empyemas of the pericardial cavity were reported and J. McF. Gaston wrote, "Surgery has thus, with impunity, invaded the citadel of life." F. P. Porcher, however, complained that, "Throughout the country a vast number of cases [of pericardial effusion] escape detection and treatment, either medical or surgical." Unfortunately this is still true today, in spite of the advent of the x-ray, because a pericardial effusion or empyema is often not thought of as a complication of a serious illness and is not recognized until an autopsy is performed.

Although fifty years ago pathologists had found evidence of healed wounds of the heart, I know of no record of that time in which suture of a cardiac wound had been attempted. Roberts made a strong plea for the making of an attempt but Paget expressed his opinion that suture was not practical because, he believed, small wounds do not need suture and large ones would kill the patient before suture was possible. Rehn, however, in 1897, successfully sutured a cardiac wound in a man who apparently was about to die. In succeeding years a large number of wounds have been

successfully sutured in patients desperately ill of loss of blood or cardiac tamponade.

Dramatic advances, such as were not dreamed of fifty years ago, have been made in cardiac surgery during recent years. In 1923, Elliott Cutler divided the two leaves of a stenotic mitral valve. Although this operation has never been successfully repeated, Cutler's first patient survived the operation, was clinically improved and lived for several years. A considerable number of successful pulmonary embolectomy operations have been reported since Kirschner's first successful case in 1924. Sauerbruch, in 1931, resected an aneurysm of the right ventricle, "the size of a child's head," and three and a half months later the patient appeared to be entirely well. A large number of cures of constrictive cardiac disease by the operation of pericardiectomy have been produced during the present century. The experimental and clinical work of Claude Beck during recent years in coronary disease and cardiac contusion is outstanding; as is well known, the various operations he has devised in order to improve the blood supply of the myocardium, has given great relief to a number of patients suffering from grave coronary occlusion. The successful ligation of a patent ductus arteriosus by Gross and Hubbard, in 1938, was soon followed by a considerable number of similar successful operations by Jones and Dolley, and by others.

FOREIGN BODIES IN THE BRONCHI

Before x-rays were available the localization of foreign bodies, especially those in the bronchi, was difficult and inaccurate, being dependent upon physical signs and, at the time of operation, upon palpation by probing. Fifty years ago, before bronchoscopy became available, the removal of those foreign bodies that could be localized was obviously difficult and the attempt frequently failed. As some foreign bodies can be expelled either through the rima glottidis or through a tracheotomy incision, and as some patients with bronchial foreign bodies

are not acutely ill, there was an inclination not to attempt removal unless the situation was desperate, or at least until pneumonia, or pulmonary abscess or gangrene seemed imminent. Removal was undertaken by means of various types of forceps, hooks and spoons introduced through a tracheotomy incision. In one case a long corkscrew was made to engage an impacted cork but its removal proved impossible. DeForest Willard, in 1891, carried out experiments on dogs in order to determine whether it would be feasible to remove intrabronchial foreign bodies by means of a transpleural approach and an opening of the bronchus in the hilum of the lung. He found the risk of severe hemorrhage enormous, and that leakage of air from the incised and sutured bronchus lead to tension pneumothorax after closure of the chest; most of the dogs he operated upon died.

With the advent of x-rays and bronchoscopy and the development, chiefly by Chevalier Jackson, of ingenious instruments for the grasping of all sorts of foreign bodies, attempted removal of foreign bodies has become highly successful and safe. When the procedure is carried out before serious pulmonary infection has developed, the patients usually recover completely. Rarely, foreign bodies become lodged in a part of the lung that is inaccessible by bronchoscopy, or become so firmly imbedded by scar tissue in accessible bronchi that they cannot be dislodged with safety. In such cases, the peripheral foreign bodies may be removed by pneumonotomy, but those in large bronchi may require partial or total lobectomy, which may also be required because of a severe complicating bronchiectasis.

ESOPHAGUS

Fibrous or carcinomatous stricture of the esophagus was well managed fifty years ago by bouginage or intubation. As esophagoscopy was not then available, however, instrumentation was carried out in difficult cases through an esophagostomy opening. Obviously, the removal of foreign bodies in the esophagus was infinitely more difficult

than it is at present with the aid of x-rays for localization and the esophagoscope for direct inspection during the seizure of the object with specially designed instruments.

One of the most fascinating accomplishments of modern surgery was the successful completion of an antethoracic esophagus, built of skin and jejunum, by Herzen, in 1907, for a patient who had an impassable esophageal stricture. Four weeks after operation the patient was able to eat bread, chopped meat, eggs, et cetera, passing these foods through the surgically constructed tube in front of the chest into the stomach.

Another dramatic operation was the successful removal of a cancerous esophagus in 1913 by Franz Torek. The esophagus was divided well below the neoplasm, the lower divided end was invaginated and the neoplasm and upper thoracic esophagus were dissected from the mediastinum and drawn out of an incision in the anterior cervical triangle, where the tumor and redundant esophagus were cut off and the esophageal stump sutured to the skin. In 1925, Torek reported that more than eleven years after operation the patient, then seventy-eight years of age, was all right and happy, and that any food that was cut or chewed into a finely divided state passed through the rubber tube that was used to connect the cervical esophagostomy and the gastrostomy openings.

CONCLUSION

Even the factual narration of the changes in surgical procedure that have taken place in a selected group of thoracic conditions does not adequately express the tremendous advance that has taken place in the practice of thoracic surgery during the last fifty years. The most striking change has not been the improvement in the technic of individual operations but the fact that today operations are being successfully performed in great numbers for almost every disease affecting the thoracic organs, whereas fifty years ago thoracic operations were relatively rare and were limited to the treatment of a very few conditions.

SOME OF THE DEVELOPMENTS IN RADIOLOGY DURING THE LAST FORTY-FIVE YEARS*

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THE specialty of radiology is one of the younger divisions of science. Though it is difficult to assign a beginning to the science of radiology, there is no doubt that the discovery of the roentgen ray by Wilhelm Konrad Röntgen and of radium by Pierre and Marie Curie were the cornerstones. It would be impossible, in the narrow limits of this presentation, to evaluate properly these discoveries. Such a task would include a careful study of the work of many scientists. In fact all the apparatus used by Röntgen in his discovery represented the labor of many students and ingenious investigators of the preceding three centuries.

Sylvannus P. Thompson, the well known English physicist, in an address before the newly founded British Roentgen Society, held on November 5, 1897, stated the following:

"November 8, 1895 will ever be memorable in the history of science. On that day a light which, so far as human observation goes, never was on land or sea, was first observed. The observer, Professor Wilhelm Konrad Röntgen. The place, the Institute of Physics in the University of Würzburg in Bavaria. What he saw with his own eyes, a faint flickering greenish illumination upon a bit of cardboard, painted over with a fluorescent chemical preparation. Upon the faintly illumined surface a line of dark shadow. All this in a carefully darkened room, from which every known kind of ray had been scrupulously excluded. In that room a Crookes tube, stimulated internally by sparks from an induction coil, but carefully covered by a shield of black cardboard, impervious to

every known kind of light, even the most intense. Yet in the darkness, expressly arranged so as to allow the eye to watch for luminous phenomena, nothing visible until the hitherto unrecognized rays, emanating from the Crookes tube and penetrating the cardboard shield, fell upon the luminescent screen, thus revealing their existence and making darkness visible.

"From seeing the illumination by the invisible rays of the fluorescent screen, and the line of shadow across it, the work of tracing back that shadow to the object which caused it, and of verifying the source of the rays to the Crookes tube, was to the practiced investigator but the work of a few minutes. The invisible rays—for they were invisible, save when they fell upon the chemically painted screen—were found to have a penetrative power hitherto unimagined. They penetrated cardboard, wood, and cloth with ease. They would each go through a thick plank or a book of 2000 pages, lighting up the screen placed on the other side. But metals such as copper, iron, lead, silver, and gold were less penetrable, the denseness of them being practically opaque. Strangest of all, while flesh was very transparent, bones were fairly opaque. And so, the discoverer, interposing his hand between the source of the rays and his bit of luminescent cardboard, saw the bones of his living hand projected in silhouette upon the screen. A great discovery was made."

The discovery of the x-rays by Röntgen was not accidental. Popular opinion would have us believe that it was. However, a careful study of the personality and the scientific background of Röntgen as well

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as all of the events that led up to the actual discovery disprove any such theory. Röntgen was one of the outstanding physicists of the nineteenth century. He began his experiments with the cathode rays in October, 1895, and it was because of his ability and his constant search for new phenomena that he ultimately was able to make such a valuable contribution.

Early publications of Röntgen's discovery occurred in this country in the *Electrical Engineer*, New York, on January 8, 1896, under the title of "Electrical Photography through Solid Matter." Other publications occurred not only in this country but in Germany and Italy and it was shortly after these early communications that the medical profession accepted the "new weapon" and promptly used it to good advantage. Röntgen's name and the news of his discovery thus became known throughout the whole world and much progress was made before the modest discoverer spoke for the first time on his "New Kind of Rays" before the Physical Medical Society at the University of Würzburg on January 23, 1896.

Shortly after Röntgen's discovery numerous scientists throughout this country and Europe began to work with feverish activity with the "new instrument" and very early, roentgen laboratories were installed in hospitals, two of the first being the New York Post-Graduate Medical School and Hospital in April, 1896, and in the Hahnemann Hospital in Chicago. Meanwhile new improvements were made especially with x-ray tubes and the fluoroscope. In addition to the diagnostic application of the x-rays they were soon found to have therapeutic possibilities. Unfortunately in this early period the workers did not appreciate the danger of the rays with which they were working and very shortly began the sad period in which the *x-ray burn* was ushered into being.

Shortly after Röntgen's discovery a French scientist, Henri Poincaré, suggested that it would be worth while to investigate whether rays produced by ordinary fluores-

cent or phosphorescent substances might be similar to those emitted by an x-ray tube. Thus it was that Henri Becquerel undertook a systematic study of some uranium compounds and much to his surprise found rays that would penetrate metal and affect photographic plates. Becquerel presented the results of his investigations on this subject to the Paris Academy of Sciences in January, February, March and November in the year 1896.

It was quite natural, therefore, that other workers should begin investigations on the uranium compounds and other elements that had similar properties, and thus it was that Pierre and Madam Curie noticed that a sample of pitchblende from an Austrian mine showed a higher radioactivity than could be accounted for by its content of either uranium or thorium. Madam Curie logically concluded that the pitchblende contained small quantities of some other substance which was more radioactive than either uranium or thorium and that that substance could not be one of the known chemical elements since she had studied all of the elements known at that time. The two investigators selected pitchblende as the ore for further studies and began to make a careful analysis of the composition of that ore. Finally they obtained a substance which had a strong radioactive content which was associated with a bismuth extract of the ore. They announced the discovery of the substance in July, 1898, and called it "Polonium." Later on they discovered that a barium extract of the ore contained much more radiation. This they called "Radium" and announced the discovery in December, 1898.

Surgery was in its full development at the time of the discovery of the x-rays and radium. That was a period in which the revelations of Pasteur and their successful applications by Lister were in full swing. It is quite natural, therefore, that the first utilization of the discovery of the x-rays should have been in relation to surgery. The striking feature of the x-rays as they

pertained to their early applications in medicine was their power to penetrate tissues in proportion to their density. Thus it became possible for one to differentiate the shadows of soft tissues from those produced by bone. Likewise it was possible to demonstrate the shadows of opaque foreign bodies.

Within a few months it became obvious that x-rays not only had the property of penetration and producing an effect on the emulsion of photographic plates but the rays also produced a definite influence on tissue cells, and almost from the beginning investigators interested themselves not only in extending the diagnostic application of the new method but were also studying its effect upon various tissues and organs.

During the first two years the diagnostic use of x-rays was limited by the inadequate and fickle types of equipment. It was possible, however, to obtain roentgenograms of fractures of the extremities and bone conditions such as osteitis deformans, gouty deformities, rheumatoid arthritis, tuberculosis of the knee joints, etc. Demonstration of the existence of foreign bodies and, in certain instances, accurate localization thereof was practiced. Later on, as the equipment improved, it was possible to demonstrate kidney stones and gallstones. Early in 1904 pyelography was being practiced by introducing an opaque material into the bladder, ureter and renal pelvis.

The clinician's attention was focused largely on the respiratory tract and the many pulmonary conditions that were so little understood at that time. Likewise, it was possible to study the movements of the heart and its various alterations in size and contour.

During the early period of roentgen therapy investigators became interested in the destructive effects of x-rays on various bacteria particularly the tubercle bacilli and those causing diphtheria. Many of the reports were contradictory; some investigators believed that x-rays would destroy bacteria and others that they would not.

Even today the action of x-rays upon bacteria in tissues is little understood. It is well recognized that x-rays have very little effect on bacteria in culture media but it is known that they do produce profound effects even by very small doses on infections in the soft tissues. It is interesting to note that in 1902 Pusey and Caldwell in their monograph, "The Roentgen Rays in Therapeutics and Diagnosis," state the following: "The fact that organisms and living tissues can be destroyed by exposing to x-rays while the same organisms in inert cultures are uninfluenced by x-ray exposure, proves positively that it is not the x-rays *per se* that causes the destruction, but that the tissues themselves, doubtless under the conditions of activity excited by the x-rays, played the important role in the germicidal process."

During the early days of roentgen therapy conditions such as cancer and skin diseases of various kinds were treated with x-rays. The operators knew little or nothing of the effects of the "new agent" yet not infrequently were they able to obtain satisfactory results. On other occasions tissue damage was produced. The early investigators became familiar with the skin manifestations produced by long and repeated x-ray exposures. These included the so-called sunburn, pigmentation, telangiectasia, atrophy, chronic dermatitis, hyperkeratosis, ulceration, epilation and changes occurring in the finger nails.

Following the discovery of radioactivity and the isolation of the radium salts by the Curies, investigations into the effects of the rays of radium on bacteria, plant life, lower forms of animal life and the various tissues of higher animals were undertaken. The concept that radium might be applied in medicine was conceived following the famous Becquerel burn in 1901, and Pierre Curie, after intentionally producing a similar burn on his arm, loaned some radium to one of the hospitals for the treatment of various skin lesions. Subsequently, through careful investigations of many of the early pioneers, techniques were developed for plac-

ing radium in small tubes in order that they might be implanted into tumors and body cavities for varying periods of time. In this country Robert Abbe, of New York, and Howard Kelly, of Baltimore, did pioneer work in developing the field of usefulness for this new therapeutic agent.

The roentgen apparatus for diagnosis and therapy in the early days was quite crude. It included static machines, induction coils and very poorly constructed gas tubes. It was not until 1907, when Snook introduced his "interrupterless transformer" with the cross-arm type of rectification, that there occurred a marked advance in the practical use of x-rays. About the same time there occurred improvements in x-ray tubes and x-ray screens and various electrical and photographic methods were developed for measuring the output of the x-ray tubes. In the early 1900's the dangers of exposures to the x-rays began to be appreciated and it was during this period that efforts were made to protect the operator and the patient from stray and unnecessary direct radiation. The operator learned by bitter experiences to keep from interposing his hand between the beam of x-rays and the patient, but very little if anything was known about the dangers of secondary rays.

The first efforts to make roentgenographic studies of the skull were unsatisfactory but as the machines became more powerful and more trustworthy, brain tumors producing new bone formation or causing erosions of the skull and those having calcium deposited within its tissues were demonstrated.

Shortly after the discovery of the x-rays, efforts were made to study the gastrointestinal tract by the use of opaque suspensions. Various types of media were used. By 1904, there was a fairly comprehensive monograph published on the roentgen examination of the digestive system by Rieder. Another phase of investigation concerned the demonstration of gallstones. This was not particularly satisfactory in that very few of the gallstones are capable

of being demonstrated by means of the survey roentgenogram of the abdomen.

This period of 1910 to 1920 was featured mainly by improvements in apparatus and technic and these were reflected in a wide extension of the roentgen examinations to numerous phases of clinical medicine. Probably the most outstanding contribution in this period was made to the study of the gastrointestinal tract. Some of the more prominent investigators would include Haudek, Cole and Carman.

There was also a rapid improvement in the roentgen examination of the urinary tract. This was probably facilitated by the development of good, intensifying screens through the efforts of Threlkeld-Edwards. It was during this period that the use of sodium iodide as an opaque medium to be introduced into the urinary tract for pyelography was developed.

The roentgen diagnosis of the chest was particularly improved during this period. Dunham, Pancoast and Baetcher did an excellent piece of work in setting up criteria or standards that they regarded as within the limits of the healthy chest. Chevalier Jackson by the aid of bronchoscopic examinations of the chest was assisting the roentgenologist to recognize conditions produced by foreign bodies and other conditions which up until this time were not well known. Jackson also introduced opaque media such as the dry bismuth subcarbonate into the lung by bronchoscopic insufflation for diagnostic purposes.

The World War brought many new developments in x-ray equipment. The demands on the radiologist were largely those concerned with mobile units in the field and in base hospitals.

During the latter part of this decade, through the investigations of Dandy, the procedures of encephalography and ventriculography were developed. Roentgen technics in the examination of the paranasal sinuses and mastoids were markedly improved.

At first the application of roentgen and radium therapy was largely confined to the destructive effect of radiation upon superficial lesions but gradually the radiosensitiveness of different tissues and organs were tested experimentally and the mechanism by which such effects were produced was partly or completely elucidated. With the knowledge that different kinds of cells vary considerably in radiosensitiveness there has developed a steady expansion of radiotherapy. Thus it was discovered that many inflammatory disorders of the skin were amenable to irradiation. Likewise the exceptional susceptibility of leukocytes, especially lymphocytes, and the remarkable action of roentgen rays and radium on lesions such as lymphoblastoma and hyperplasia of the thymus were discovered. It was during this period that the action of the α -rays upon the epithelium of the ovary was revealed by the investigations of Albers-Schönberg, Regaud and others. It was through such observations that hemorrhagic conditions and fibroma myomas of the uterus were treated.

Subsequently, researches by Bergonie and Tribondeau yielded the information that young, rapidly growing cells were more radiosensitive than mature adult cells, and this, together with the still more important fact that each variety of cell has specific sensitiveness to radiation, constitutes the essential basis of radiotherapy and explains most of the effects noted at the irradiation.

From 1910 to 1920 methods of determining the dosage or output of α -ray tubes were improved. α -ray tubes themselves were improved. Radiotherapists began to learn more about the various types of filters. Improved technics in treatment and methods were developed by which the patient could be protected from unnecessary irradiation.

Since the close of the World War the specialty of radiology has widened its boundary and has now rendered a useful service in almost every specialty of medicine. Not only is radiology playing an important role in medicine but it is render-

ing a real service in other fields such as in industry.

The development since 1920 has been to some extent through new apparatus such as the Potter-Bucky diaphragm, α -ray tubes of higher capacities, improved fluoroscopic and intensifying screens, better transformers and a number of special devices for facilitating special procedures. Probably the most important contribution has been through certain discoveries which will be discussed later.

The investigations in the study of the respiratory tract were remarkably developed during the period since 1920. The work of Jackson and Manges in the localization of foreign bodies in the upper and lower respiratory passages deserves special recognition. Further work, with particular reference to the heart and large vessels has revealed information which has improved the radiologist's ability to render more help in the diagnosis of certain heart lesions. There is still much to be done, however, before the roentgen examination of the heart can be of real assistance to the cardiologist. Chest diagnosis has improved particularly with regard to the diagnosis of malignant tumors and bronchiectasis following the use of opaque media such as lipiodol.

Collective studies have been made concerning the roentgen appearances of the various diseases involving bones and joints and at the present time the roentgen diagnosis of deficiency diseases and bone lesions such as syphilis and bone tumors can be made with a certain degree of accuracy. Through the anatomic and pathologic studies of Schmörl and others the roentgen diagnosis of lesions involving the spine has received a great impetus.

The roentgen examination of the urinary tract, both by excretion urography and retrograde pyelography has improved tremendously. The discoveries of Lichwitz, Swick and von Lichtenberg have been a tremendous boon to urology in that it is now not only possible to demonstrate lesions within the urinary tract but it is possible also to study its function following

the administration of one of the uroselectan series. The procedures of ventriculography, encephalography and myelography are being used with increased frequency. Lipiodol instilled into the paranasal sinuses has assisted one in rendering the correct roentgen diagnosis on occasions when it was not possible to make a diagnosis by the conventional examination. The examination of the neck and upper respiratory tract including the pharynx, cervical esophagus, larynx and cervical trachea has been popularized through the collective studies of Hay. Sialography, an injection of lipiodol or some opaque substance into the duct of the salivary gland, is another procedure that has assisted the surgeon.

Roentgen studies in the gastrointestinal tract continue to improve as we learn more about the gastrointestinal physiology. It is now possible to diagnose most organic lesions in the esophagus, stomach, duodenum, small intestines and colon. Not only are opaque media used but certain contrast media such as air or gas are employed with barium sulfate to show the mucosal folds of the various portions of the gastrointestinal tract.

Probably one of the greatest contributions to the diagnosis of gastrointestinal lesions has been through the agency of the Miller-Abbott tube in the diagnosis of intestinal obstructions. This tube renders it possible for one not only to make a diagnosis of an obstruction but also to ascertain the type of obstruction and its location. It also renders it possible for one to decompress the patient so that the operation instead of being an emergency may become an elective procedure.

The roentgenologic diagnosis of the gallbladder received a great boon in 1924 through the method known as cholecystography developed by Graham, Cole, Copher and Moore. The method necessitates the administration of a dye, sodium tetraiodophenolphthalein either by mouth or intravenously. The dye is excreted by the liver, stored by the gallbladder and renders the shadow of the lumen of that organ visible on the roentgenogram. It is

now possible, with this method, to diagnose to some degree the function of the gallbladder as well as to demonstrate various abnormalities and diseases of that organ. The ability to demonstrate nonopaque gallstones in many instances has been proved conclusively.

Another procedure that has helped the surgeon in gallbladder surgery is known as cholangiography. This procedure requires the introduction of an opaque oil into the gallbladder and biliary radicals, either at the time of or following operation. It is used to demonstrate whether the ducts are patulous or if there are stones, growths, etc., blocking them.

The field of pelvimetry still seems to be a fertile one for the development of technics to assist the obstetrician in the examination of those patients who may have some dystocia. The procedure of hysterosalpinography has been developed in latter years to an even greater degree, especially, following the work of Sicard and Forestier. This examination requires the introduction of lipiodol into the body cavity of the uterus and into the fallopian tubes, and is used largely to tell whether the tubes are patulous or whether there are any mural lesions encroaching upon the lumen of the uterine canal.

Although arteriography was practiced very early following the discovery of the x-ray, it has been developed more recently largely through the perfecting of thorotrast and uroselectan. Uroselectan is being used in increased frequency for demonstrating lesions in the arteries and veins and to some extent in conditions involving the heart and great vessels.

One of the most recent developments in the field of roentgen diagnosis is body section roentgenography. This is not a new procedure as it was described a number of years ago; but largely through the work of Andrews, Kieffer, Moore, Scott and others, and the development of new pieces of apparatus, the procedure is receiving increasing attention. There are a number of indications for the use of body section roentgenography but body section roent-

genograms were not very satisfactory for interpretation until recently.

The development of modern methods of treatment since 1920 in roentgen and radium therapy has been due principally to several things which have more or less complimented each other: First, improved apparatus with a tendency toward increasing the voltage. At the present time there are a number of 1000 kilovolt machines distributed throughout the United States; second, the physical measurements of the x-ray tube and machine are now so well standardized that everyone using roentgen therapy throughout the United States should be able to obtain correct information concerning the dosage and output of the x-ray tubes, third, the development by physical measurements of isodose curves showing the percentage rate of absorption and scattering in the tissues; fourth, increased information obtained from biologic experiments; and finally, the knowledge derived from the reports of collective studies on various conditions that have received radiation therapy. The radiologist of today is well informed and all physicians should learn that in order to get the most out of this new therapeutic agent there should be close cooperation between all of the physicians managing the care of patients.

The improvement in radium therapy has corresponded to that obtained with roentgen therapy. There have been improved methods in the application of radium. It is now possible to get radium put up in any type of container and there are companies that can send radium to those physicians who know how to apply it anywhere in the United States. The use of radium for the most part has been confined to applications within body cavities, superficial conditions and lesions in which it is necessary to implant radon or platinum radium needles.

During the past few years the intense study of the atom and the atomic nucleus by physicists throughout the world has resulted in contributions of incalculable value to biology and medicine. Perhaps the most important of these developments is the induction of artificial radioactivity in

practically all of the elements and a new penetrating form of radiation called the neutron ray. Indeed it seems that because of these discoveries medicine will benefit to a degree similar to that following the discoveries of x-rays by Röntgen and of natural radioactivity by Becquerel and the Curies. Some of the discoveries that led to the development of the *cyclotron* include those of Joliot and Curie, son-in-law and daughter respectively of Pierre and Marie Curie, for in 1934 they reported that radionitrogen, radiosilicon and radiomagnesium had been produced artificially in their laboratory. This induced activity resulted when certain elements were bombarded with alpha particles of radium. Prior to that contribution Urey and his associates, in 1932, reported the discovery of heavy hydrogen and finally, in 1936, E. O. Lawrence and D. Cooksie reported the development of a new apparatus for the multiple acceleration of light ions to high speeds by which they could produce large quantities of radioactive elements. This instrument they called the "cyclotron" and in it *deuterons* are accelerated to high speeds equivalent to 5,000,000 volts or more and then directed against targets of various elements which are made radioactive.

Thus it is that during the last twenty years x-ray machines have been developed for treatment that varied from potentials of 40 kv. to those in excess of 1000 kv. and finally through the contribution of Lawrence and his associates we have a new instrument, the "cyclotron." At this early period the cyclotron is an unknown, so far as medicine is concerned, but sufficient experiments have been carried out to show that it does have an effect on biologic materials of various kinds, it can produce radioactive isotopes and it does affect the various tissues of the body. In fact there are several cyclotrons being built at this time, some for pure science and others for therapeutic purposes. Again, pure science has made and is making unpredictable but practical contributions to the problems of biology and medicine.

Radiology in this country is barely forty-five years of age yet in that brief period this branch of medical science has made colossal strides. Skinner aptly states that "no other fields of human research has enjoyed such immediate and universal participation, such profound adaptability to problems of human diseases, such extensive availability to the world's population and such benefits to unconquered fields of diagnosis and therapy as roentgen diagnosis and radiation therapy." There have been a number of agencies that have had an influence upon the specialty of radiology so far as education is concerned. These might be listed as follows: (1) The influence of the American Medical Association upon medical education in general. (2) The influence of radiological societies upon medical education. These radiological societies include The American Roentgen Ray Society, established in 1900, The American Radium Society, organized in 1916, The Radiological Society of North America, founded in 1920, and the American College of Radiology in 1923. (3) The influence of the Council on Medical Education and Hospitals of the American Medical Association. For a long time this Council has had an advisory committee which have drawn up "essentials" for admission to the list of physicians specializing in "radiology." (4) The requirements of the Council on Medical Education concerning radiological services in hospitals. Very early the Council set up definite requirements, which were asked of the hospital before it could be approved for training internes. (5) The American Board of Radiology. The American Board along with other specialty boards in this country has set up certain standards which must be fulfilled by those wishing to enter the field of radiology. At present there are in excess of 1000 radiologists who have been certified by the American Board.

In concluding this paper which has been a very sketchy survey of some of the highlights occurring in radiology during the past forty-five years I am of the opinion that attention should be called to the fact that in radiology there is a real opportunity

for the ambitious and well trained young physician. The field is fresh, fertile and uncrowded and there are many questions to be answered and avenues to be explored.

It seems to me that an excerpt from an address by Harold W. Dodds, president of Princeton University, is peculiarly fitting: "Plato's immortal allegory of the men seen in a cave was never more appropriate than today. You remember that the unfortunate creatures, representing society in general, were bound in the darkness with their faces to the wall; that there is a fire behind them and that real figures pass between them and the fire, so that the imprisoned men can see the shadows of the figures on the wall, but never the figures themselves, in reality. Occasionally a prisoner is freed from his chains and led above to the daylight where he learns the reality behind the shadows and learns how imperfect were his early impressions. Therefore, it becomes his duty to return to the cave and help disperse the ignorance of his fellows."

Does not this allegory express the opportunity and obligations the radiologist owes to medicine? Is it not our duty, having seen the reality, to train men with the talent, the intellect, and the will to work, so that they, in turn, may be able properly to interpret the shadows in the light of modern physiology and pathology?

ACKNOWLEDGMENT

In preparing this paper the author wishes to acknowledge the generous help that he obtained from the material written by Drs. C. H. Orndoff, Otto Glasser, Percy Brown, U. V. Portmann, Harry H. Bowring and Robert E. Fricke and published in *The Science of Radiology* by Charles C. Thomas, Springfield, 1933. The author also wishes to acknowledge information obtained from an article by Dr. Arthur U. Desjardins, *The Status of Radiology*, published in the *J. A. M. A.*, May 23, 1931, page 1749, and an article on Artificial Radioactivity and Neutrons in Biology in Medicine written by John H. Lawrence and published as a reprint by the Council on Physical Therapy of the American Medical Association.

FIFTY YEARS OF ANESTHESIA

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PERIOD OF DISCOVERY AND EMPIRICAL USE

ANESTHESIA was foreshadowed by the discovery of ether, by an Italian, Valerius Cordus, in 1540, three centuries before its *anesthetic* properties were discovered. Oxygen and nitrous oxide were discovered by an English clergyman and scientist, Priestly, in 1774, over seventy years before their use in surgery. Von Liebig, in Germany, Samuel Guthrie, in America, and Souberan, in France, independently, discovered chloroform in 1831, sixteen years before its use as an anesthetic.

Henry Hill Hickman, an English surgeon, in 1820 to 1828, made successful experiments upon lower animals, rendering them insensible to pain, by the inhalation of nitrous oxide or carbon dioxide and the exclusion of air, and then proved insensibility to pain by performing various minor operations on these animals, but his work was treated with skepticism and scorn and he was not allowed to test his theories upon human beings.

The discovery of the anesthetic properties of ether and nitrous oxide was made by observations of a doctor (Long) and a dentist (Wells). They proved that ether and nitrous oxide when inhaled to a point of intoxication, at "Ether Frolics" or "Chemical Lectures," the human subjects were unaware of bruises or painful spots received while in a semi-intoxicated stage.

Dr. Crawford W. Long, of Georgia, in 1842, was the first to use any drug (ether) in a surgical operation, to render the patient insensible to pain.*

* The words, *anesthesia* and *anesthetic*, were then unknown. Oliver Wendell Holmes suggested the word (November 21, 1846).

Horace Wells, a dentist, in 1844, was the first to use nitrous oxide. His public demonstration was a failure, but he continued to use it in his private practice. W. T. G. Morton, also a dentist, was the first to demonstrate successfully in public (October 16, 1846) the anesthetic properties of ether (suggested by Jackson, a chemist).

Ether for surgery and nitrous oxide in dentistry were quite generally used shortly after their discovery and introduction. J. Y. Simpson, a doctor of Edinburgh, Scotland, had used ether quite extensively in his obstetric practice, but the crude use of ether alone with its disagreeable odor, nausea and vomiting was especially repugnant to his patients. From Waldie, a chemist, Simpson obtained chloroform, which he immediately tested upon himself and other doctors. He found it pleasanter to inhale and that it produced the same results as ether. One year after Morton's successful demonstration of ether, Simpson commenced using it in his practice, in 1847, as did others. All anesthetics at this time were used in an entirely empirical manner, as nothing was known of the physiology or possible harmful effects of the substances used.

Simpson was the pioneer and the first physician in history to give an anesthetic for the relief of pain in childbirth. Opposition to this procedure was intense by physicians and clergy as evidenced by the following incident:

Dr. Simpson was called to Windsor Castle to deliver Queen Victoria under the new anesthetic. On his lecture room door, he posted a notice: "Professor Simpson has gone to deliver the Queen." Under this notice, some one, probably a student, wrote, "God save the Queen!" However, Her Majesty was so pleased that she

knighted the worthy doctor, thus bestowing upon him the highest honors of the British Government. Tradition and superstition were superseded by the fact that in this notable instance anesthesia was safe in childbirth. In 1847, Flourens, in France, discovered the anesthetic properties of ethyl chloride. Six years later, in 1853, Alexander Wood, in England, invented the hypodermic needle, which made possible local, intravenous, regional and spinal anesthesia.

PERIOD OF SCIENTIFIC ADVANCEMENT

The fundamentals for the scientific advancement of all methods of anesthesia, as we know them today, were thus given to us to experiment with and develop in a scientific manner.

The drop method of inhalation anesthesia was universally used. The patient was placed upon the operating table, and as the second or stage of excitement was reached, he was pinioned down by attendants, until the third stage with relaxation occurred. Then the attendants retired and the patient was prepared for operation. Upon return to bed after the operation, nausea and vomiting were usual and always serious in abdominal operations, and occasionally were fatal. No other form of anesthesia was used at that time.

Dr. Thomas L. Bennett, of New York City, after studying in England (1895), and acquiring the method from Hewitt, of London, developed an apparatus, and introduced the "gas-ether" sequence in America, in 1896 to 1897. Bennett was the first physician in America to devote himself exclusively to anesthesia (1896 to 1932, thirty-six years), although it was customary in England from almost the first discovery of anesthetics.

The "gas-ether" method consisted of a very simple apparatus for getting the patient under nitrous oxide first, then switching gradually to ether and continuing the anesthetic with ether, thus eliminating attendants, the second stage and, to a great extent, nausea and vomiting. This method

was so obviously an improvement upon the "open" or drop method of giving ether that it was universally adopted.

A familiar saying of Bennett's was that he had given "over thirty thousand (30,000) anesthetics without a death." But not everyone who gave anesthetics had the natural and acquired skill of Bennett and surgeons began to experiment with other agents and methods. The foundation of local and spinal anesthesia was the discovery in 1858 of the alkaloid of cocoa leaves, by Albert Niemann. Scraff discovered the analgesic properties of cocaine when placed on the tongue. Carl Kohler (1884) demonstrated its anesthetic value when placed in the eye. William Stewart Halstead and James A. Corning gave clinical demonstrations in 1885 of its value. "Spinal anesthesia largely replaced local anesthesia for operations below the diaphragm." (Hertzler, in "Local Anesthesia.")

Local anesthesia rapidly advanced with the introduction of novocain, which was discovered by Einhorn and was first clinically tested by Braun in 1905. It is from seven to ten times less toxic than cocaine, its solutions stand boiling and keep without deteriorating for a long time. Its action is increased and prolonged by the addition of adrenalin. Its derivatives are even less toxic and more suitable in every way than novocain.

A method of combining local and inhalation anesthesia, was developed by Crile and Lower of Cleveland, in 1920. The method is known as *anociation*, and when combined with preliminary medication, prevents fear, pain, shock and postoperative nervous manifestations. A minimum of each anesthetic is used, and the patient gets the benefit in increased safety and comfort.

INTRAVENOUS, SPINAL AND LOCAL ANESTHESIA

Research by laboratory workers has produced such definite results for intravenous, spinal and local anesthesia that, together with the increased knowledge and skill of the surgeons, relief from pain is as safe and

certain with these drugs, as with inhalation anesthesia. "The dangers of spinal anesthesia lie with the user more than

to promote the use of local anesthesia. The author has seen Dr. Mitchell do operations in his office under local agents that would



FIG. 1. No preliminary medication. Air spaces filled with edematous fluid; perivascular edema; congestion.

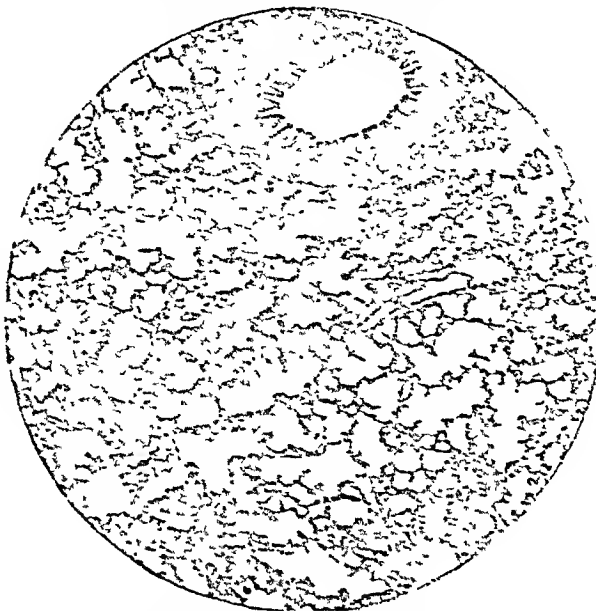


FIG. 2. Preliminary medication. Air spaces and bronchi clear; no perivascular edema or congestion.

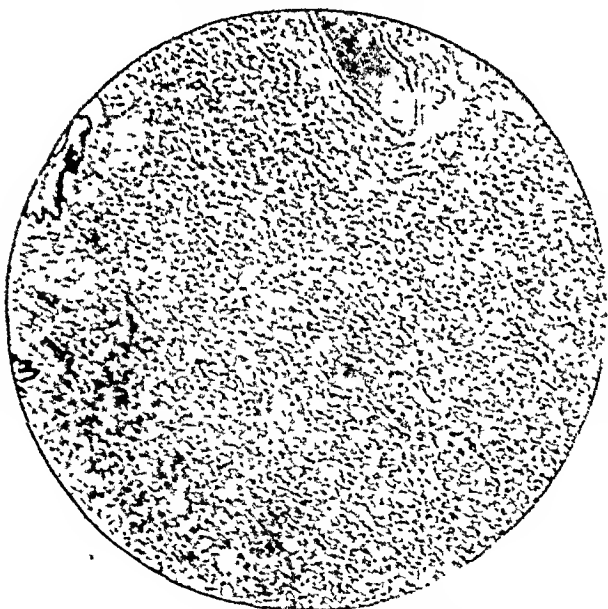


FIG. 3. No preliminary medication. Massive atelectasis and congestion; air spaces obliterated.



FIG. 4. Preliminary medication. Lung tissue relatively normal.

The work of Charles W. Hooper, assisted by the author. From Autochrome photomicrographs in Nelson's Looseleaf Surgery, Vol. 1, page 514.

the drug." (Babcock-Maxson, in "Spinal Anesthesia.")

Dr. James F. Mitchell, a surgeon in Washington, D. C., by his writings and skill in the use of the needle, has done much

usually be performed in a hospital under an inhalation anesthetic.

Professor Gaston Labat, of New York University, was the outstanding teacher of regional and spinal anesthesia, of his day.

Professor Babcock, of Temple University, Philadelphia, in his textbook on Surgery (1938), reported ten thousand (10,000) prefers spinal anesthesia (using procain), and uses it exclusively in obstetrics after having tried all other relief methods.



FIG. 5. No preliminary medication. Ethylene 94 per cent, oxygen 6 per cent. Extensive alveolar and perivascular edema; air spaces filled with fluid.

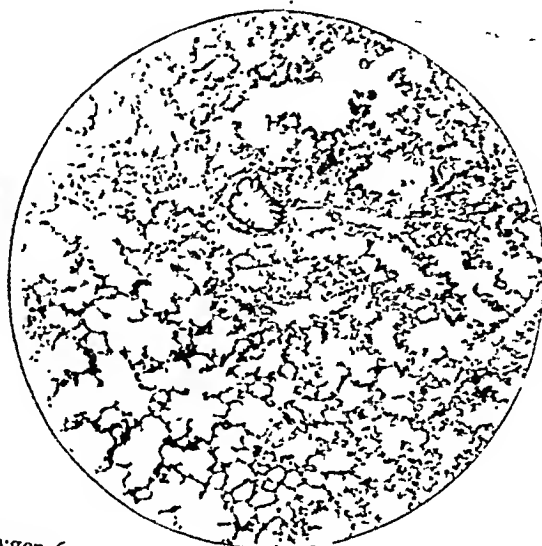


FIG. 6. Preliminary medication. Fairly normal lung tissue.



FIG. 7. No preliminary medication. Acetylene 94 per cent, oxygen 6 per cent. Alveolar and perivascular edema.

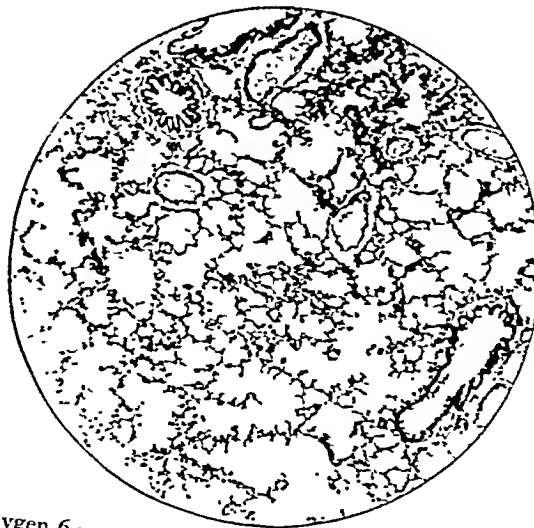


FIG. 8. Preliminary medication. Normal lung tissue.

spinal anesthetics without a death. Under the guidance and supervision of John Lundy, of the Mayo Clinic, the number of operations under spinal and regional anesthesia outnumber those under inhalation anesthesia. Dr. Cosgrove, of Jersey City,

George Pitkin, of New Jersey, has done as much as anyone else in calling attention to the value of spinal anesthesia.

Methods of administering local, spinal and regional anesthesia are now taught in all medical colleges, but it will probably be

another decade before they are universally used. "Spinal anesthesia was used once in 1924 and more than 3,000 times in 1939." (Mayo Clinic.)

hundred and six (106) surgical operations under this gas, in April 1923, at the Presbyterian Hospital, in Chicago. It has a wider margin of safety than nitrous oxide,



FIG. 9. No preliminary medication. Extensive alveolar and perivascular edema; congestion.



FIG. 10. Preliminary medication. Relatively normal lung tissue.

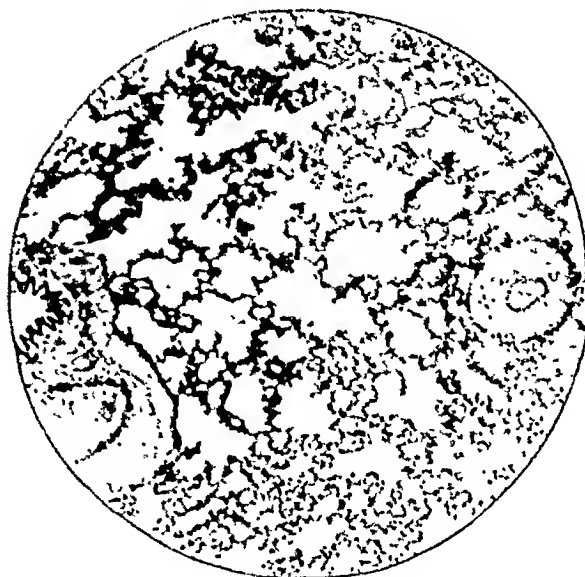


FIG. 11. No preliminary medication. Perivascular edema, air spaces relatively clear.

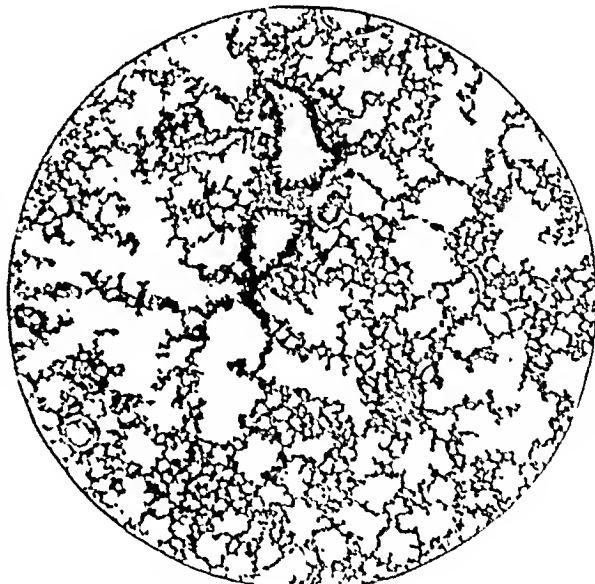


FIG. 12. Preliminary medication. Normal lung tissue.

Ethylene (C_2H_4) was discovered by Ingenhauss, in 1779. Its anesthetic property was demonstrated on animals in the laboratory by Luessem, in 1885. Luckhardt and Carter made experiments on its physiologic properties, and reported one

and more oxygen can be used with it to produce the same degree of surgical anesthesia than when nitrous oxide is used. It supplied a long felt need. Ethylene has been used 58,690 times up to December 31, 1939, at the Mayo Clinic.

The objections to it, are its odor and its explosive nature. It should, therefore, be used with nitrous oxide. That is, the introduction should be with nitrous oxide and the maintenance with ethylene and oxygen. The terminal anesthetic should again be nitrous oxide and oxygen to eliminate whatever taste and odor may remain in the upper air passages of the patient.

Professor Chauncey D. Leake concludes his paper, "The Historical Development of Surgical Anesthesia," with this statement: "One of the most significant points emphasized in recent works, is the importance of Oxygen in anesthetic conditions. An anesthetic agent is being sought, which is to be administered with so much Oxygen, that all deleterious effects incident to Oxygen want, can be reduced to the minimum."

It would seem that *cyclopropane* is the answer to Professor Leake's wish. It was first prepared by August von Freund, in 1882, but no notice was taken of his discovery until nearly fifty years later (1929), when Lucas and Henderson published their laboratory experiments on animals. They found that anesthesia could be maintained by using 10 per cent to 12 per cent cyclopropane, with 88 per cent to 90 per cent oxygen, with but little change in blood pressure, metabolism or blood sugar and with no damage to the liver. There was a wide margin of safety between the surgical and the lethal dose. Consciousness was regained in from one to three minutes. Respiration always failed before circulation, therefore, immediate measures should always be successful.

Four years after these experimental findings, the first clinical administration was given by Neff, Rovenstine and Waters (1930), of the University of Wisconsin. Under the direction of Ralph W. Waters, professor of anesthesia at the University of Wisconsin, the technic was successfully developed, and in 1937, they reported over two thousand (2,000) administrations. The indications and contraindications for cyclopropane are practically the same as for

nitrous oxide or ethylene. On account of its expense, Waters evolved the carbon dioxide absorption technic. This consists of passing the respirations through a mixture of calcium and sodium hydrate, so that the carbon dioxide is absorbed, and the respirations are kept within physiologic limits. In this way, a minimum amount of cyclopropane is used.

It is the most inflammable and explosive of all gases used in anesthesia. In spite of its many advantages and its careful introductions, deaths have occurred, principally from explosions, and, therefore, has been definitely excluded from some hospitals. Its very great advantage over other agents is that it gives a relaxation equal to that of spinal anesthesia. In order to do this, however, many anesthetists produce anoxia and then carry on respiration by pressure on the gas bag, thus producing artificial respiration. Other anesthetists claim that this is unnecessary. It would seem from conflicting reports, that cyclopropane is still on the waiting lists.

Cyclopropane has ushered in the golden era for the manufacturers of anesthetic apparatus. The latest gas machines have attachments for nitrous oxide, ethylene, cyclopropane, helium, carbon dioxide, ether and oxygen, so that the selection may be made as indicated by the patient's condition.

Vinethene: (vinyl ether, divinyl oxide) has a formula of:

	Per Cent
Pure divinyl ether	96.49
Absolute alcohol	3.5
Nonvolatile oxidation inhibitor	0.01

Vinyl ether was first suggested by Leake (Leake and Chen); it was synthesized by Major and Ruigh, and its pharmacology was studied by Leake and Gelfan and associates.

Vinethene is a clear, colorless liquid with a boiling point ten to thirteen points below the boiling point of ether. Its action is quicker and recovery is more rapid than with ether. It was developed as an anesthetic, at the University of Pennsylvania,

by I. S. Ravdin, professor of surgery, and his associates, and has been used over five thousand times in that institution. It is now employed for painful dressings and for operations of *less than one hour*, in obstetrics and dentistry, and especially for children.

Liver damage to one patient, in an operation lasting over two hours, caused the use of vinethene to be discontinued except for short operations; it is now used with oxygen which decreases the possibility of liver damage. The ratio of the anesthetic dose of vinethene to the lethal dose, is 1 to 2.4; with ethyl ether it is 1 to 1.5. For short operations, vinethene is safer than ethyl chloride; it is accompanied by less nausea and vomiting and is not as toxic to the liver as chloroform.

It is used routinely at the University of Pennsylvania, for short operations, such as, opening abscesses, inserting drainage tubes and applying painful dressings. *It should be seen in use, by those who wish to employ it*, under Professor Ravdin's direction.

COLONIC ANESTHESIA

This method was first mentioned nearly one hundred years ago, in 1847, by Pirigoff. His method was first to introduce liquid ether, and next he devised a method of vaporizing the ether by means of heat, and thus administer the drug. He reported eighty-one (81) cases, with two deaths, but the method fell into disuse. Cunningham, of Boston, in 1905, added to the technic by employing air to carry ether vapor into the intestine, a more sensible, safer, and satisfactory plan.

In 1910, Sutton published the results of a series of one hundred and forty cases at the Roosevelt Hospital, by using an apparatus consisting of three parts: (1) The generator in which the mixture of oxygen and ether was made, (2) an afferent tube system which carried this product into the intestine, and (3) an efferent for exhausting the contents of the bowel.

This method was successful, but the apparatus was so complicated that its use

was never attempted by others. The record of cases of Cunningham and Sutton were prominent factors in the development of oil-ether colonic anesthesia.

OIL-ETHER COLONIC ANESTHESIA

In 1913, at the seventeenth International Medical Congress in London, the author read a paper on oil-ether colonic anesthesia. The experimental work on animals was completed just previous to this date.

George Barkley Wallace, professor of pharmacology of the University and Bellevue Medical College, conducted experimental laboratory work on animals. He found that the heart rate, respiration and blood pressure were evenly maintained in a dog under oil-ether rectal anesthesia, an experiment repeated many times with the same result.

The late Charles Baskerville, professor of chemistry, of the College of the City of New York, made laboratory experiments to determine: (1) A comparison of the rate of evaporation of ether from different mixtures of ether and the same oil, and, (2) a comparison of the rate of evaporation of ether from the same per cent mixtures of different oils.

The oils used were vegetable, animal and mineral. He demonstrated that regardless of the per cent mixture, the rate of evaporation remained constant. This would seem to indicate that oil-ether, administered colonically, is a safe procedure, giving an absolutely even plane of anesthesia.

In the laboratories of the Department of Health of New York City, experiments were conducted under supervision of the Director of the Bureau, William H. Park, on the bacterioidal action of oil-ether mixture against the *Bacillus coli*. These tests showed that the mixture killed practically all *B. coli* in from five to fifteen minutes after exposure.

All of this work was completed in 1912 to 1913. Thus it will be seen that this method of anesthesia was most thoroughly tested before being tried upon human beings.

Clinical results were as satisfactory as the laboratory experiments. Reviewing thousands of cases with this method, we find that pulse, respiration and blood pressure remain more nearly normal with this method than with inhalation, spinal, regional or local anesthesia. The amount for the average adult, weighing about one hundred and fifty pounds, (ether, 5 ounces, oil, 2½ ounces) lasts two and one half to three hours. If the operation lasts longer, only *small* supplements are indicated, as the result is more analgesic than anesthetic. Trained nurses administer the oil-ether. It is only necessary for the anesthetist to note and rectify the condition of the patient before removal from bed, i.e., twenty minutes before operation.

LATHESIA

Recently, F. E. Guntrip, of Santa Clara, California, has invented a rubber mixture that mixes readily with ether, and reduces both the amount to be given and the expense of administration. These reasons make it superior to the oil-ether. Five ounces of ether in *lathesia*, is only five ounces, instead of the oil-ether seven and one half to eight ounces. It acts, clinically in every way as the oil-ether mixture and should popularize both the surgical and obstetrical procedures.

OBSTETRICAL ANALGESIA

An offshoot of oil-ether colonic anesthesia is the method developed for the relief of pain in obstetrics. The ideal sought was the relief of pain, with consciousness but little, if at all impaired, so that full cooperation is obtained at all times. The method was developed at the Lying-in Hospital of New York City, in 1923, exactly ten years after its successful development for surgical purposes. The method was developed under the direct supervision of Asa B. Davis, Chief, and his staff.

At that time, (1923) between three hundred and four hundred confinements occurred each month, in this hospital. Seven years later, in 1930, twenty thousand

(20,000) cases were reported with the above method, from the Lying-in Hospital and other hospitals, with no increase in morbidity or mortality.

In the same year, (1930), modifications and improvements of the above method, were made by C. O. McCormick, of Indianapolis. His method was intended for the general practitioner as well as for the expert. The cooperation of the patient is enlisted, and the pain is the criterion as to when to give medication, instead of dilatation of the cervix and the usual multiple examinations. He invented a special apparatus for giving the oil-ether, by which the instillation is completed in thirty or forty seconds, instead of ten to fifteen minutes, the time necessary with the earlier catheter or funnel method. The retention is higher, better and more comfortable. Over one hundred thousand cases (100,000) of oil-ether obstetrical anesthesia, with and without McCormick modifications, have been reported in the United States without danger to mother or child. The method is now used routinely at the Indiana University School of Medicine, also at the Temple Hospital in Philadelphia and in many other hospitals. In his new book, Arnold states: "The unprejudiced testing and weighing of drugs and methods, so far developed, lead us to the conclusion that, all things considered, the Modified Gwathmey Course comes nearest to meeting all demands, under the widest range of circumstances, and therefore, that is what we shall continue to preach and practice until convinced that there is something better."

At the annual meeting of the American Medical Association, in 1939, W. C. C. Cole read a paper in which he states that a comparison of the weights of one thousand babies, showed that the loss of weight in the new born, was not physiologic as universally believed. The weight of the babies, whose mothers had received ether, was better than the weight of the babies of the untreated patients. This would seem to make it imperative for the obstetrician to

use ether for relieving pain in childbirth. C. A. Smith, of Boston, in a paper on the "Effect of Obstetric Anesthesia on Oxygenation of Maternal and Fetal Blood, with Particular Reference to Cyclopropane," states that, "Judged by biochemical data, Cyclopropane as an obstetrical anesthetic, appears to be, perhaps, less safe for the infant than the clinical appearance of the mother would indicate." Also: "In general, Ether anesthesia definitely increased the Oxygen capacity of maternal blood, and under this anesthesia, fetal Oxygenation appeared to be satisfactory." From all sources, then, it would seem that ether and oil per rectum, and ether and oxygen by inhalation, are ideal anesthetics in childbirth.

The endotracheal, endobronchial and nasotracheal anesthesia, and the more general use of the ordinary air-way tubes, have unquestionably made all forms of anesthesia safer.

PRELIMINARY MEDICATION

The data now given have been published in Nelson's Loose Leaf Surgery. Observations upon the value of preliminary medication in preventing morbidity and mortality, are not as generally known as they should be. It is our firm belief that all patients should be put to sleep and awakened in their own beds in a state of analgesia. Our reasons for this are based, as are all advanced surgical methods, upon laboratory research.

The second stage of anesthesia, commonly known as the stage of excitement, raises the blood pressure from 10 to 40 mm. systolic, ordinarily and occasionally up to 80 to 90 mm. just prior to administration of the anesthetic. This is true, even when patients are given the ordinary hypodermic of morphine ($\frac{1}{8}$ to $\frac{1}{4}$ gr.), which proves that this so-called preliminary does not completely remove psychic impulses. Pneumonia and other postoperative troubles, ordinarily attributed to ether, are due to the patient's not having received proper preliminary medication.

Almost forty years after the discovery of

ether, Alexander Crombie, of the Calcutta Medical College, applied Claude Bernard's idea of pre-anesthetic medication of morphine, and thus in a great measure, abolished the disagreeable features of ether administration. As stated above, experience has proved that this medication is not satisfactory now.

LABORATORY EXPERIMENTS WITH PRELIMINARY MEDICATION

It has been proved experimentally, by Professor George Barclay Wallace, of the Pharmacological Department of the New York University and Bellevue Hospital Medical College, that when ether is administered intravenously, without preliminary medication, nearly twice as much anesthetic is required to produce anesthesia, as when preliminary medication is used. Again, without preliminary medication, a very small amount of ether produces respiratory paralysis, whereas, with preliminary medication, two and a half times the amount of ether is required to produce the same result. This proves that a laboratory animal is much safer with preliminary medication than without. The above experiment was verified several years later with ether, propylene, acetylene, ethylene and nitrous oxide administered by inhalation.

This research was under the supervision of the late Charles W. Hooper, assisted by the writer. It represents a year's work in which approximately five hundred (500) animals were employed to determine the value of preliminary medication, in inhalation anesthesia. Half of the animals were used as controls and the other half were given preliminary medication; all of them were placed in the same gas chamber. The animals without the preliminary medication had a stage of excitement, jumped around and struggled against the anesthetic. The animals with preliminary medication never moved, but sank quickly and quietly under the anesthetic and lived twice as long as the controls in the same gas chamber. Necropsy revealed that their lungs were relatively normal. The lungs of

the animals that had not received preliminary medication, on gross examination, showed distention, edema and congestion. Microscopic lesions were perivascular edema, diffused petechiae and alveolar spaces filled with fluid. The bronchi contained edematous fluid. Other organs appeared normal.

Surgeons and anesthetists in various parts of the country employ different methods and drugs for putting patients fast asleep in their own beds. It is almost the universal custom of those giving cyclopropane to use avertin with amylene hydrate per rectum for this purpose. When the anesthesia is properly timed they also awaken in bed. Others using ethylene or ether with oxygen have used evipal rectally, but in the last few years have used pentothal sodium (sodium ethyl barbiturate) with anhydrous sodium carbonate as a buffer given rectally as the basal anesthetic. The patient goes to sleep in three to fifteen minutes, never knows when he is taken to the operating room or when the mask is applied to the face, and usually awakens in his own bed. These methods follow and are in conformity with the laboratory experiments of Wallace and Hooper. The use of oxygen throughout all operations and immediately afterwards is rapidly increasing with all methods of analgesia and anesthesia.

PRESENT PROFESSIONAL STATUS OF ANESTHETISTS

The greatest advance in anesthesia is the changed attitude of the medical profession as a whole toward anesthesia and anesthetists. It is a far cry from the misery and mental suffering of the pioneers and discoverers of anesthesia to the statement of August 31, 1940, in the *Journal of the American Medical Association* giving complete recognition to the American Board of Anesthesiology, an affiliate of the American Board of Surgery, thus placing those qualified anesthetists upon the same professional status as other members of the profession. This board charges a fee of seventy-five

dollars for an examination, which if passed, gives the anesthetist a standing in the medical profession, fully equal to that of other members of the profession.

The change has been very gradual, as with other specialties in medicine. Probably no one deserves greater credit than the late F. H. McMeekan, editor and secretary general of the publication devoted to anesthesia, especially in America, and covering anesthetics in all parts of the world. All of us will agree with Howard W. Haggard when he states that "For this progress, we owe a great debt to one of the bravest men I have ever met, Dr. F. H. McMeekan." Fortunately, for the cause of anesthesia, we have unusually competent men to fill his place: the editor of *Anesthesiology*, Paul M. Wood, and Charles J. Wells, secretary of the Associated Anesthetists of the United States and Canada.

The 1936 Year Book of the American College of Surgeons, states: "The science of anesthesia is rapidly developing. New types of anesthesia, new methods of administration, and complicated apparatus demand serious medical thought. It is unfortunate that a large number of hospitals fail to recognize the necessity and value of a well organized department of anesthesia. This presupposes competent medical supervision, preferably a medical anesthetist. . . . Such a requirement does not preclude the use of the nurse anesthetist, who is properly trained and qualified to give anesthesia. It is unfair to expect the nurse to be responsible for the service, but rather, she should work under proper medical supervision. As the administration of anesthesia is generally conceded to be the practice of medicine, and in as much as it involves risk to human life, it is only reasonable to expect medical supervision. This cannot be done properly by the surgeon, for he is frequently not especially trained in this work, nor should he have to carry the responsibility, when under the strain of operating."

So great has been the advance in discovery and administration that within the

last few years professors of anesthesia have been appointed in medical colleges, and skilled physicians are devoting their time exclusively to research in anesthesia in certain medical centers.

At the University of Wisconsin, in Madison, Ralph W. Waters has been appointed professor of anesthesia, with a staff for research and anesthetic work. E. A. Roventine, professor of anesthesia in New York University College of Medicine, has the same standing as other professors in the University. John Lundy, of the Mayo Clinic, Rochester, Minnesota, has long been an outstanding figure in anesthesia. He now has a staff and is devoting himself especially to regional and spinal anesthesia. Other colleges and universities are rapidly falling in line.

Yandell Henderson, professor of physiology, at Yale University, first called attention to the value of carbon dioxide, in 1906. He has also pointed out the mistake of assuming that nitrous oxide is the safest of all anesthetics, whereas, it has a very narrow margin of safety, and complete anesthesia can hardly be acquired without anoxemia. In many other ways, he has promoted the science of anesthesia.

The next great advancement in the suppression of pain, will be the discovery of

some substance, taken as a pill or as a hypodermic, that will produce *general* analgesia and thus entirely eliminate all present forms of anesthesia, as it will be much safer, easier and pleasanter both to give and to take.

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HOSPITALS: 1890-1940

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IN a brief presentation like this the author can only sketch what seem to him to be the major developments in the field of hospitalization since the founding of the American Journal of Surgery fifty years ago. Limitations of space prevent the achievement of comprehensiveness while, on the other hand, an effort can be made to give coherence to a series of hospital developments which have contributed to the civilizing influences of our time.

The chronicler of hospital events, who is seeking at the same time to appraise each phenomenon as it presented itself, must lean heavily against the general historic background of his subject. The last fifty years have been densely crowded with historic events and changes have been taking place at a comparatively rapid pace during this period. This must be borne in mind, since hospitals are expected to respond promptly to social and economic changes, while cooperating with the public health movement in helping to prolong the lives of men and opening new continents. In times of peace, when planning is a calm discipline of the mind, and in time of war, when the response is on an emergency basis, the progressive hospital is in a constant state of adjustment. The stimulus in the former case comes from the normal progress of science in the biologic and mechanical world. In the latter case it is the compelling need for a victorious conclusion by the selection and care of qualified men and their rehabilitation for field service if they have suffered wounds in battle through the perverted application of the social and mechanical sciences.

The reader of a well established medical publication, such as the older *Lancet* (London, England) for the year 1890, must

be impressed with the fact that human nature in hospital work has not changed, though human nurture has been teaching us how to extend the span of life by preventing and conquering disease. The same stern and compelling humanitarianism breathes in its pages and vitalizes them, as we find in the vastly detailed and sometimes burdensome hospital literature of today. Though the charitable motive dominates the picture in both cases, we of the machine age reluctantly come to the conclusion that pious words about the patient are not enough. The journal room of the hospital library in those days, if it were in existence, was not the time-consuming phenomenon of scientific hospital life that we know today; but that is because its contents showed less ramifications into the specialties and subspecialties, and because the day of fine discovery and invention had not yet fully dawned on the profession. If great deeds in the hospital are being recorded by the historian today, they were being recorded, too, in those days, with this difference: the last half century has brought the industrial revolution and the complex mechanical era to the hospital with on-rushing speed. The student of applied sociology, working in the modern hospital, is now concerned with the danger of losing sight of the individual in the surge of mass production and mass planning.

Fifty years ago medical men in hospitals were preoccupied with clinical situations which called forth the best use of the five senses, unassisted for the large part by the instruments of precision and the labor-saving devices that are in common use today. The interne who orders a complete "workup" on his patient would do well to read how self-reliant his immediate professional ancestors were in the diagnosis and

treatment of disease. The endoscopic procedures, improved illumination, magnification, transillumination, the x-ray, a large variety of diagnostic tests and mechanical therapeutic procedures, without which the modern physician does not move, were still unknown in 1890 and the hospital was that much simpler in structure as well as equipment. If this is to be called the scientific age, that was still the age of empiricism when the lights of modern science were beginning to illuminate the hospital world. Those were the days when men still took pride in shotgun prescription writing and placed great faith in it. The secret remedy was in far greater evidence. Serotherapy, radiotherapy, chemotherapy, physical therapy generally and the bolder and more extensive operative procedures were still unknown and the span of life was far from the three score and ten which we are approaching today. The horse-drawn ambulance clattering along the cobblestone streets on the way to a dreaded Bellevue Hospital was the forerunner of the deluxe motor ambulance and its more acceptable destination that we know today.

One author, writing on "Paroxysmal Hurry of the Heart" in the *Lancet* of 1890, may not have learned to construct the word tachycardia—and he preceded by twelve years the work of Einthoven with the string galvanometer—yet he wrote intelligently and even scientifically with the limited materials at his disposal about a clinical condition, largely functional, which seems to have been far less frequent in those days than it is in the fast-moving society that is under such severe nervous tension today. The cardiographic laboratory of the modern hospital is a development of the last twenty years and is an excellent example of the manner in which the hospital has been adapting itself to new ideas. It shows the interest of the governing authorities of hospitals in diagnostic apparatus which may be helpful, but which may not be absolutely indispensable.

The electrical engineer and the physicist have made numerous other great contribu-

tions during the last fifty years. Apart from the power plant, which is the heart of the hospital buildings, there is the field of physical and electrical diagnosis and therapy represented by the departments of radiography, radiotherapy, physical therapy generally, and such electrical instruments as the cautery, the cardiograph and the encephalograph, not to mention the various aids to the handicapped patient. One need only mention the difference in the illumination of the field of surgical operation between the twentieth century and the gas-light era to appreciate the contribution of electricity to the development of the modern hospital. The modern signal systems and the telephone switchboard, have speeded help and cooperation where, at the beginning of this period, messages were delayed because they had to be entrusted orally or in writing to slow methods of delivery. Safety for patients and staff in hospitals and the prevention of accidents of all kinds are contributions of the mechanical specialties which seem almost to have been unknown at the end of the nineteenth century.

Another way of illustrating the historical achievement of the modern hospital is to exhibit the medical chart of the patient in its evolutionary stages between the years 1890 and 1940. In the earlier days the "chart" of the patient was done in handwriting and recorded, for each medical episode separately, in a bound annual collective volume, each patient receiving scant notice of a few pages. Contrast the unit system of record keeping in the specially constructed and equipped record room in the modern hospital, where clinical biographies are complete in individual open folders from the time the ambulatory patient enters the out-patient department, (including records of previous hospitalization) through his stay in the wards, and ending with his ambulatory visits to the follow-up clinic. The volume of the modern chart, representation of the various specialties in its pages, graphic notes, cooperative opinions, microscopic tests and findings—

and the possibilities of their use in series for the purpose of education and scientific deduction are striking, indeed, when one reduction in infant mortality among civilized peoples. Typhoid fever was rampant in the earlier period and devastating epi-



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turns the pages of history back a brief fifty years.

In the earlier period new and epochal discoveries in the field of the infectious diseases were in the making. If the life expectancy is now more than sixty-one years, it is largely because of the conquest of the infectious diseases and the sharp

demics of all kinds still prevailed. Nowadays the teacher is hard put to it to find a case for demonstration to students. The great influenza epidemic, which swept the world at the end of the Great War, came at a time when epidemics in civilized countries were becoming less frequent. It taxed hospital ingenuity to the limit. The cause

and cure of diphtheria were just beginning to dawn on the medical profession in the early 1890's. Prevention of this dreaded disease had yet to wait many years before Schick brought fulfillment. Meantime, important work had been done in the symptomatic treatment of diphtheritic complications. O'Dwyer invented the method of intubation for laryngeal diphtheria to tide patients over this hitherto fatal complication.

Those were the days of primitive isolation hospitals, some of which still survive in the form of asylums, pest houses, almshouses and poor-farms in various parts of the globe. The contrast of the hospitals of the metropolitan cities of today with their immaculate sanitary conveniences is striking, but that is because we know so much more about our bacteriologic enemies and therefore need not fear them.

In the field of anesthesia we find, as we continue reading, that the hospitals of the earlier days were preoccupied with the dangers of chloroform. This found expression in numerous articles, and letters to the editor, apart from the work of the Hyderabad Commission. Our concern with the danger of explosions in operating rooms of hospitals from the use of the newer anesthetics these days is reminiscent of the struggles of the first part of the last half century with this vexing problem: chloroform and sudden death; ether and illuminating gas; cyclopropane and ethylene and static electricity. New inventions and discoveries seem to bring new problems while solving old ones, and they compel a revaluation and readjustment of hospital facilities from day to day.

The tempo of scientific life in hospitals has increased progressively, mostly during the last half of the period under review, and we sometimes wonder whether money which is intended to accelerate research productivity and hasten the arrival of more and more preventives, comforts and cures, could not, in some part, be used to slow up the tempo and ease the nerves and the mind of the harrassed worker, in an era which is

bewildering enough because of many conflicting forces. Of one thing we may be certain, and this is that money invested in hospitals fifty years ago brought larger proportionate returns than the vastly increased expenditures of today. This, however, is another way of saying that in the early stages small investments in hospital service, as in the case of primitive communities today, bring proportionately larger returns. As time goes on and the expenditure is increased, an optimum point is reached when the return begins to become relatively smaller. From the dormitory type of hospital which prevailed fifty years ago, we have evolved the luxurious institutions which serve the sick today. The single and double rooms, the small wards and the separation rooms in the hospitals of today were almost unknown at the end of the nineteenth century. The results are doubtless better today but they are beyond a doubt costly.

The reader of the *Lancet* for the year 1890 will also find, to stimulate his interest in the quaint approaches to the scientific medicine of those days, that the earlier generation was engrossed with the subject of hypnosis. Our own preoccupation with psychoanalysis is strangely reminiscent of those earlier days. The scientific student of psychology, perhaps many years ahead of his time, now insists on a cold and calculating approach to most, if not all, spiritual ills and some that are physical. Hypnosis found its place in hospitals for a time, but psychoanalysis is still an extramural activity and we are left wondering whether the exclusion of this combined diagnostic and therapeutic activity should not in itself be psychoanalyzed.

During the half century under review, hospitals have been profoundly influenced by the genius of medical men. This is but another way of saying that hospitals, apart from their fundamental purpose of serving the patient, have become the laboratories of the medical profession and responsive to that profession to a high degree. The specialty of administrative medicine, which

makes use of a number of special technics and which is altogether a twentieth century development, has for one of its major objectives the principle of service to the medical men of science. The clinician, freed of executive duties, has more time for his patients, while leaving administrative functions to those who are talented that way. This is in response to the spirit of the times which calls for the division of labor on a specialized basis. The days have gone when broken down clinical or clerical war horses can hope to lead a hospital group successfully. We now have such a cooperative achievement as the Hospital Standardization Conference of the American College of Surgeons in the United States. Clinician and administrator have contributed mightily, each in his way, to this cooperative relationship. Occasionally one group has successfully reached over into the field of the other, but this could only happen in the small hospital.

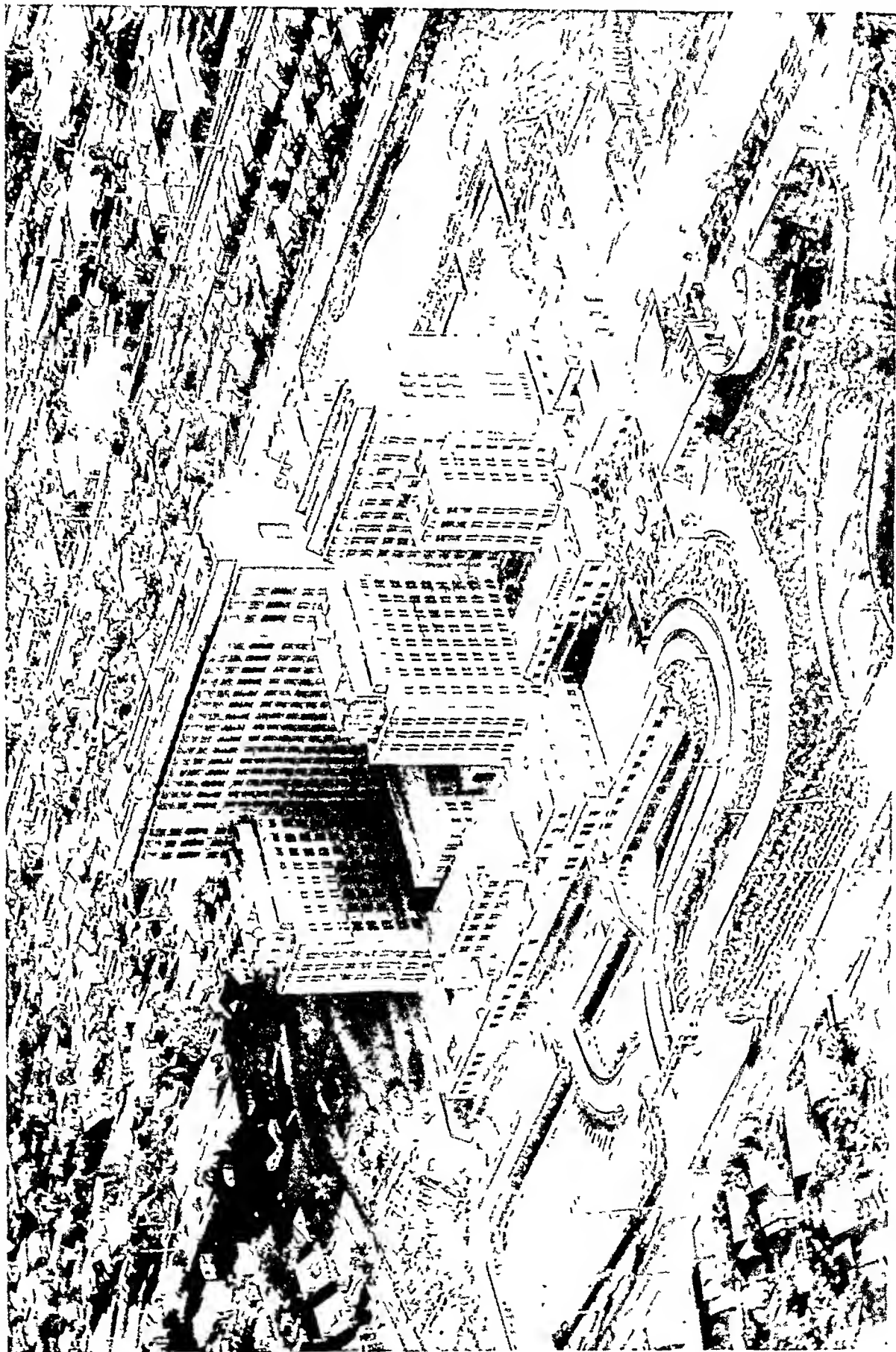
During the last half century medical men have so impressed their personalities on hospitals as to be inseparable from them biographically. There are numerous instances of great physicians creating great hospitals and of great hospitals creating great physicians. Dominating personalities may, indeed, be identified everywhere, in the clinic and in the office of the administration. In the management of the modern hospital, and particularly in hospital architecture, Dr. S. S. Goldwater's pioneer work is the outstanding contribution of the last three decades. In the field of group medicine, which has come to the fore as a by-product of the era of specialization and consequent cooperative effort, many notable contributions have been made in this country by clinicians. The work of the Mayos in the field of hospitalization occupies an honored chapter in the history of the hospitals of the twentieth century. In the related field of medical social service we find such an outstanding protagonist as Dr. Richard C. Cabot, working in the Massachusetts General Hospital as early as 1905. In the earlier years, a pioneer in

the nursing world, Florence Nightingale, had left her impress on the hospitals which she helped so much to improve, and this was true not only in the nursing sphere, but also in the sphere of nutrition and organization.

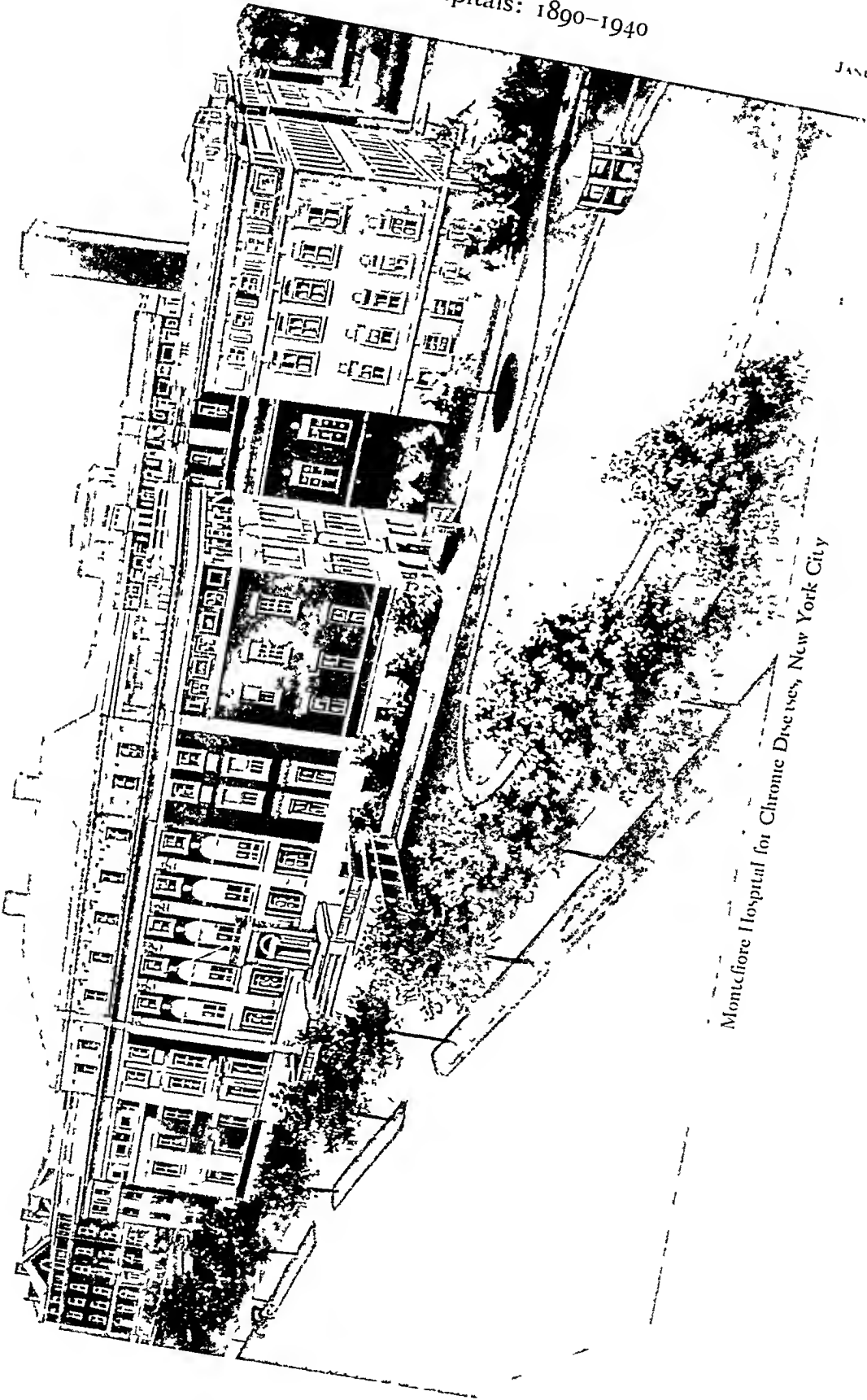
Though we still have the "cancer hospital," "home for incurables," "sanatorium for consumptives," and "lunatic asylum," as reminders of earlier designations, the tendency during this period has been to employ more euphemistic names to spare the feelings of the sick and their families. However, we are told by the public relations experts, who have recently made their appearance in the hospital, that the survival of these designations may be justified on the ground that they bring a better financial response from philanthropists who have charity in their hearts.

We have witnessed within this period the rise and start of decline of the special hospital. Integration of all specialties in groups of buildings, under the heading "general hospital," where the natural history of disease can be studied in all of its phases from infancy to old age, regardless of the mental or the physical character of the illness and regardless of the acute or chronic nature of the illness, is now the ideal. Specialization on a cooperative basis and an escape from the tendency to segregate and isolate patients away from scientific facilities at a time when they may need them most, pervades current hospital thinking on this subject.

From the smaller hospital units of 1890 we have developed an architectural plan which now includes skyscraper hospitals as well as extensive pavilion systems. The former have been made possible by the development of vertical transportation which was unknown in the beginning of the last half century. The last decade has seen the advent of the "medical center" where special hospitals are joined, often by merger with a parent general hospital, in an integrated scheme which one would be justified in calling a true medical center, if additional facilities for chronic disease were



Air View of the Los Angeles County General Hospital



Montefiore Hospital for Chronic Diseases, New York City

included. Most of the medical centers came into being at a time during the 1920's when great industrial mergers were taking place and the new hospital plan produced economic as well as social advantages. The size of the hospital unit has also increased from small beginnings in 1890 to hospitals of almost 10,000 bed capacity in 1940.

The insignificant per capita cost of maintaining a patient per day in 1890 has been multiplied several times over again with the passing of the years. Taking one large and important general hospital in New York as an example, we find that six times as many patients were cared for in the year 1939 as compared with 1890. The expense of maintaining this hospital, however, has multiplied twenty-four times within this period. This hospital treated 17,360 patients at the end of the fifty year period as compared to 2,862 patients at the beginning, and it spent \$2,374,088 to take care of these patients as compared with \$100,000 at the beginning of this period. These are significant figures, even if a dollar did go farther in those days. The disproportionate increase in expenditure per capita is doubtless due to the introduction and maintenance of improved facilities and the cost of experimenting with such facilities though, in the latter case, we now have the characteristic extrabudgetary fund which is earmarked for research work in hospitals and not included in the per capita cost figures. Higher costs have purchased better housing, better equipment, improved labor conditions for employees of all categories, better general and special nursing and expensive diagnostic and therapeutic facilities which have multiplied through the years. It is interesting to note, on reading the meager hospital reports of the earlier days, that deficits were played up as much then as they are now, but this is because we have not yet discovered a better substitute for appealing to the generosity of the community. Goldwater says somewhere that "a deficit is often the symbol of a noble ambition."

Hospitals may now be classed as a group

among the leading major industries of this country. The total investment is in excess of three billion dollars and, at the turning point of the prosperous era in 1929, this investment was being increased at the rate of two hundred million dollars a year. The cost accountant has been unable as yet to produce an orderly picture of hospital bookkeeping and this is because of the ramifications and the rapid changes inherent in hospital service. The United States has one million beds distributed among 8,000 hospitals and half of these beds are in hospitals for mental disease. We have no accurate figures for the year 1890, but the United States Bureau of Education reported only 35,453 beds throughout the country in 1873. The figure for 1890 was doubtless much more, but it seems tiny when one contemplates the hospital field today.

The growth of specialization in hospitals is one of their major developments during the last half century. If specialization in its various forms and the division of labor are characteristic of our time, they are in full evidence in the modern hospital and it is in this phase of organization that one of the sharpest forms of contrast may be found with the hospital era which opened fifty years ago. The modern hospital draws on the industrial world, the business world, the field of hotel management, as well as mechanical engineering and the related professions for various technics and for stimulation in its progress upward.

X-ray diagnosis and later x-ray and radium therapy, the contributions to the modern hospital of Roentgen and later the Curies, have stimulated the creation of special laboratories in hospitals and outpatient departments. For the medical man these new developments meant greater clinical opportunities in diagnosis and therapy. It was left, characteristically, to the hospital administrator and to the physicist to work out the details of construction, protection, equipment and organization, and the result typified the cooperative spirit of the times when hospi-

tals responded promptly to new inventions and new discoveries as to needs and possible methods for dealing with them.

A few examples of special departments in hospitals might here be given. Occupational therapy came fully into its own and into the hospital as a by-product of military medicine in the zone of the interior during and after the Great War. It was a natural consequence of greater social as well as medical interest in the patient. The follow-up clinic for discharged ward patients came first, then occupational therapy and lastly rehabilitational therapy as the most recent development of record. Such organizations for the rehabilitation of the patient after discharge as the Altro Work Shops in New York came into being in 1913 for the purpose of providing sheltered workshops where the former tuberculous patient could be restored to industry by gradual steps under medical and nursing supervision. The physician, working in the hospital, now knows that the right which has been conferred upon him to prescribe involves the obligation to follow-up. The tendency to integrate service to the sick and see the responsibility through to the end has been responsible for such phenomena during the last twenty years as the union of the in- and out-patient staffs of hospitals, the follow-up clinics, the social service exchange and, as the most recent event, (accepted by the voluntary hospitals only in principle as yet) the union of the acute and the chronic hospital.

Physical therapy belongs to the latter part of this period and no hospital considers itself complete these days without the basic modalities in hydrotherapy, thermotherapy, electrotherapy and mechanotherapy. The medical profession has been slow to learn that the treatment of a patient is not always a matter of drugs or surgery and has paid dearly for its conservatism in the growth of a number of cults which magnify out of all proportion some form of cure which has restricted scientific application. This tendency left such specialties as physical therapy in a fog

for many years and it is only in the last decade that the scientific physical therapist has been coming into his own. The war which has been waged on nostrums and quackery in recent decades by such representative organizations as the American Medical Association, has done much to purify the atmosphere around hospitals and to make them safe for scientific medicine. Dental service to patients in hospitals came on the horizon thirty years ago despite the expense, and now occupies an honored place among the specialties.

The sanitation of the modern hospital is a matter of major concern to the administration. The last fifty years have witnessed the epoch-making growth of bacteriology and the establishment of preventive medicine as a specialty. Studies on infection and immunity have influenced the growth of the hospital profoundly. This is true not alone of the wards, where patients may safely be kept together, but also of the sanitation of the hospital in all of its far-flung activities. Sanitary conveniences of all kinds (including air-conditioning) facilities for sterilization, the practice of asepsis generally—these are characteristic of the modern American hospital.

Asepsis in the operating room of 1940 is far different from what it was in 1890. Surgeons of those days, who are still with us, love to startle us by telling how the operator would pick up the scalpel which had fallen to the floor, wipe it on his apron and proceed with the operation. Howard Lilienthal, in one of his published reminiscences recently, wrote the following: "To see Gruening extract a cataract was something never to be forgotten. Cocaine, a gift to the world by Carl Koller, was not employed when the case was that of an obstreperous patient, chloroform being then given the preference. The Graefe knife was held in the mouth of the operator, its ivory handle projecting from the right, the keen blade from the left, barely missing the gray beard and the luxuriant moustache. The local preparations of the operative field were made: the scrubbing and irrigation of

the conjunctival sac, the insertion of the speculum. The corneal section was then skillfully executed and the knife at once conveniently replaced. The cystotome divided the capsule, usually after iridectomy, the lens was extracted and the bandage applied. Through it all, gentle quiet conversation went on defying what would ordinarily be regarded as an impediment to speech." Then the author, with a twinkle in his eye, adds this sentence: "Although there had been apparent disregard of asepsis or antisepsis, not a single case of infection was observed by me." Contrast those days with these when the science of ophthalmology has been revolutionized by the slit-lamp and corneal microscope of less than two decades ago and read what Charles B. Meding has to say after fifty years of ophthalmic surgery: "I witnessed extractions by Herman Knapp in 1888 and by Nettleship in 1889. I have never seen either surpassed in method, skill or results."

In a later paragraph, Lilienthal relates the following: "An anecdote follows, illustrating what can be done with perfect technical surgery and no attempt at asepsis: In my first year of practice there was a case of impassable stricture of the deep urethra in which I had asked Dr. Fluhrer to be present to share responsibility and to lend a hand if necessary. A filiform bougie was passed as far as it would go and then perineal section was undertaken by me. Things went too slowly and finally Fluhrer took the knife. Believe it or not, he sharpened the blade on his shoe and with a few swift strokes the urethra was entered. There was no postoperative complication. The wound, of course, was left wide open, and the perfect drainage took care of possible contamination."

Asepsis is almost odorless now, by contrast with the odor of "doctor" and "hospital" of the earlier days. The bolder surgical approaches were not yet being attempted then. The complication of shock was not clearly understood and intravenous medication was as yet unknown. Though we like to feel, in our search for the ideal,

that the entire purpose of medicine is to obviate the need for surgery, we have discovered and invented ways and means of relieving suffering by operative procedures which were not dreamt of fifty years ago. The hospital has contributed, in large measure, to the development of the science of surgery, for it is true that without the operating room facilities of the modern hospital surgery would not have made the great strides which are its glory now. In the earlier days McBurney in this country and Treves in England were taking public pride in the newly developed operation of appendectomy. Today the hospital operating room witnesses the most delicate neurosurgery, the most extensive thoracic surgery and the finest kind of abdominal surgery. The universal performance of certain types of surgery in hospitals, of which the tonsil and adenoid operation is a good example, reached its height and receded in the period under review. The enthusiast in the hospital is happily subject to scientific influences and clinical conferences which are now mandatory.

The single room laboratory of 1890 has grown into the elaborate separate building of later years and, while the earlier unit was limited to clinical microscopy and elementary pathology, we now have the great subdivisions of gross and microscopic pathology, physiology, pharmacology, biochemistry, bacteriology, serology and hematology, each under the jurisdiction of a specialist in the larger hospitals. The necropsy averages in the hospitals of America today are far in excess of what they were fifty years ago, soon after Rokitansky went to his reward and while Virchow was completing his monumental contribution to cellular pathology.

One can only guess the emotions of the medical giants of the end of the nineteenth century if they could return and survey the hospital facilities of today. Reviewing the pages of the *Lancet* once more, we pick at random such dominating clinical figures in hospitals as Brown-Séquard, Charcot, Gowers, Hughlings Jackson and His in the

field of neurology; Koch, Pasteur and Ehrlich in the field of the infections; Billroth, Lister, Von Bergmann and Mikulicz in surgery, our own Abraham Jacobi in the field of pediatrics and the philosophy of medicine, Paget and Notlinagel ("Nur ein guter mensch kann ein guter arzt sein") in medicine and Helmholtz in physics. There were many others, too numerous to mention, each of whom left his indelible impress on the developing hospital of his time. Oliver Wendell Holmes, 81 years old when this Journal was born, would have been an interesting commentator on some of the hospital practices of today.

With the passage of the last fifty years life expectancy is twenty years closer to the Biblical span than it was in 1890. This, too, has brought its hospital problems for with the conquest of the infectious diseases which this period has seen we are now confronted with more and more of the degenerative and of the malignant diseases which prevail in middle life and in old age. This has brought the problem of chronic disease to the fore and hospital authorities are now giving this subject some of their best thought. One need not lay claim to the gift of prophecy in predicting that the next major development in hospitals will take place in this field. There is still but one independent hospital for chronic disease of high standard in the voluntary classification and that is the Montefiore Hospital for Chronic Diseases in New York. Most hospital workers agree that provisions will have to be made shortly for this type of patient who requires the best scientific service that may be available.

In the year 1890, and for some time thereafter, the tendency of deliberately keeping the mortality rate low by avoiding too many surgical risks and the exclusion of the hopeless type of case was still noticeable in hospitals. We have more effective ways of judging hospital efficiency now. There is far less tendency these days to refuse admission to a patient on the ground of either duration of illness, age,

prognosis, curability or economic condition. The hospital, as a temporary home for the sick, is a far more popular institution than it was at the end of the nineteenth century and all classes of society now enjoy its benefits.

It was not till the turn of the century that the better hospitals in this country began to recognize clinical differentiation and established independent services such as the neurologic division. At about the same time private pavilions for the wealthier classes began to appear in voluntary hospitals. Many of them helped to maintain the wards of these hospitals. X-ray departments made their appearance at about the same time. Dietetics, now called the science of nutrition, appeared five years later as a thoughtful commentary, in a sense, on the surviving hospital pharmacy of the earlier days. The newly discovered relation of food to disease found expression in the modern dietotherapy departments of hospitals. Shortly thereafter medical social service, with its tremendous special contribution to the cure of the sick, made its appearance. It was not till the 1920's that a few of the better hospitals in the metropolitan area began to establish pay clinics, diagnostic clinics and consultation services where the benefits of group medicine could be provided at cost.

Proprietary hospitals have been multiplying of late and these are maintained for profit, while serving the medical profession as "open hospitals." The maternity hospital, either as an independent institution or as part of the general hospital, put in an appearance and vastly more babies are now being born in hospitals than ever before. The midwife of the earlier days has almost disappeared from larger communities. Coincident with the growth of the maternity hospital came the concern of the medical profession over the rise in maternal mortality.

A very recent development in the field of medical sociology and medical economics and one which bids fair to strengthen the financial support of voluntary hospitals, is

the group-insurance movement which is so well represented by the Associated Hospital Service of New York. The voluntary hospitals are an integral part of this movement and contribute to its development in various ways. More than five million subscribers in this country are now eligible for private hospital care, many of whom would have been compelled to accept ward service during illness.

In the field of American hospital literature, we find the establishment of *The Modern Hospital* (Chicago) twenty-seven years ago, the first important publication in the field of hospital journalism. This subject had previously received only brief notices in the medical journals. The most recent contribution in this field is the magazine known as *Hospitals*, which first appeared five years ago as the official organ of the American Hospital Association, succeeding the earlier *Bulletin of Hospital Management and Hospital Progress* also contribute their share to this new field of activity. Books on hospital administration have begun to appear during the last decade and there are signs of greater interest in this activity in the near future. The three-volume *Hospital Survey of the City of New York*, the last and most important of the group hospital surveys, published in 1938 under the auspices of the United Hospital Fund of New York, is an excellent example of awakening communal interest in an orderly hospital program.

In the field of organization we find the advent of the American Hospital Association in 1899 and its ultimate expansion to include more than 2,500 member hospitals, besides an equal number of personal members. The International Hospital Association got off to an auspicious start in America in 1929, but became one of the casualties of the second World War ten years later. At the moment of writing the Pan-American Hospital Association is in the process of organization. The American College of Hospital Administrators made its appearance in 1934 and is a rapidly growing

influence in the development of the American hospital.

Among the standardizing bodies which have promoted the scientific and ethical interests of the hospital one finds the American Hospital Association, the American College of Hospital Administrators, the American College of Surgeons, and the American Medical Association, each of which has a vital interest in the development of the program of hospitalization in this country. Apart from these, numerous state and regional hospital organizations have come into being. Organized medical bodies like the county medical societies and the academies of medicine maintain committees on hospital service and cooperate actively with hospitals. Organization is a characteristic of our time and many a physician has begun to complain about burdensome committee work in a perplexing era of scientific and economic competition.

We have also to record the growth of hospital councils in recent years. These are, for the most part, coordinating bodies which seek to distribute hospital service on a high plane in situations in which it is most needed. Among helpful cooperating bodies are such related organizations as the National Tuberculosis Association, the American Society for the Control of Cancer, the Welfare Council of New York, and such joint activities as the New York Committee on the Study of Hospital Internships and Residencies which have a voice in the development of the hospital educational program.

During the period under review we have seen the rise of the philanthropic contribution, best exemplified in the voluntary hospital—the pacemaker of all hospitals and therefore the aristocrat of the group which has achieved a great measure of success through voluntary effort and initiative on the one hand, and the absence of political influence and bureaucracy on the other. However, the great depression which descended on us in 1929 has had a profound

influence on the ability of philanthropy to continue its contribution and it may very well be that the financing of hospitals in the years to come will have to be radically altered. The development of cooperative effort in the collection of funds along the lines of the United Hospital Fund of New York, which was organized in 1879, has received impetus particularly in the last two decades of this period. Generally speaking, government subsidies to voluntary hospitals have been on the increase.

It must be recorded that labor relations in hospitals have improved to a marked degree in recent years coincident with the tendencies of the social security movement in this country. Hospital payrolls now account for 60 per cent of the expenditures of the hospital. The radio, the talking picture and the aeroplane have had their influence on hospital service. The better hospitals now have radio outlets at the bedside. They also have talking pictures, not only to entertain patients in hospitals but also to teach students medical and surgical diagnosis and therapy. The aeroplane ambulance has shortened distances between the sick in outlying communities and the medical centers. Patients no longer fear either voluntary or public hospitals as they did fifty years ago and they do, indeed, seek hospitalization far more frequently today than they did in the earlier years. The establishment of a separate department of hospitals in the administration of the City of New York seven years ago marked a turning point in the confidence of the public in municipal hospitals.

There were practically no major educational requirements, as prerequisites for the study of medicine for the class of 1890, and graduates were not yet obliged to submit to examination for license to practice medicine in those days. Tuition fees were low. The course of study had just been increased from two to three years. This should be compared with the high standards of admission in 1940 and the length of time and considerable expense which must now be faced by a good student wishing to perfect

himself and measure up to the requirements of the specialty boards of later years. The requirement of hospital internship, which now prevails in many states, came as a much later development. There are several important medical schools today which do not grant doctors' degrees in medicine before the completion of a one-year hospital internship.

The contribution of the hospital to medical education has been extended in scope, particularly during the last decade. Flexner's report, almost thirty years ago, still finds an echo in the modern hospital. The various licensing boards in the specialties depend on the cooperation of hospitals for the training of general and special medical men. In recent decades we have witnessed the growth of fellowship subsidies for research work in hospitals and there has been a general tendency to increase the number of full-time and part-time medical service in the clinics, as well as in the laboratories of the hospital.

A number of epochal changes have revolutionized society since this Journal was born and each of them has had its influence on the development of the modern hospital. The decade before the turn of the century was by far the most calm of this entire period, ushering in the dawn of a new era for the hospital. Medical men, singly, predominated and the hospital formed the background. This was followed by the pre-war period when a number of our best hospitals some called, for obvious reasons, university hospitals, came into being. Hospitals became better known and shared honors with medical groups. The Great War precipitated a number of new and varied hospital movements, some under military influence. Then came the post-war period of readjustment and the development of the veterans' hospitals in this country. That came to be known, after the year 1929, as the prosperous era, and it was in those years that hospital architecture and planning reached its highest achievement in America. The great depression which followed brought retrenchment and

economies in expenditure. Schools of nursing which had flourished and drew heavily on hospitals for their sustenance began to close because of an overproduction of nurses, and physicians, who had given generously of their time for the care of the sick poor in hospitals and dispensaries,

finding their very existence menaced, began to clamor for subsidies to neutralize their losses in private practice. Now, we are in the midst of a second destructive conflagration in the world and there is no prophet among us who can confidently look into the future.



Correction: Dr. Louis J. Hirschman wishes to correct a statement made in his article entitled "Anal Fissure," on page 639 published in this Journal in December. In speaking of watery solutions of local anesthetics Dr. Hirschman mentioned a 2 per cent nupercaine solution. This should have read $\frac{1}{10}$ of 1 per cent.

SURGERY AND THE AMERICAN MEDICAL ASSOCIATION

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CHICAGO, ILLINOIS

FROM the very foundation of the American Medical Association in 1847 surgeons have played a conspicuous part in its leadership.

THE PRESIDENTS

In the ninety-three years during which the organization has functioned (during two of which there were no sessions and no elections to the presidency), fifty-one surgeons have held the office of president. Thus, out of a total of ninety-one presidents, fifty-one have been surgeons—certainly a large percentage in view of the fact that the surgeons have seldom constituted as much as 10 per cent of the membership.

The names of the surgeons who served as president follow, together with the year and the place of meeting at which they served:

Year and Place of Meeting	President	Year and Place of Meeting	President
1848 Baltimore	Alexander H. Stevens, New York	1882 St. Paul	J. J. Woodward, U. S. Army
1849 Boston	John C. Warren, Massachusetts	1883 Cleveland	John L. Athlet, Pennsylvania
1850 Cincinnati	Reuben D. Mussey, Ohio	1885 New Orleans	H. F. Campbell, Georgia
1851 Charleston, South Carolina	James Moultrie, South Carolina	1886 St. Louis	William Brodie, Michigan
1853 New York	Jonathan Knight, Connecticut	1887 Chicago	L. H. Gregory, Missouri
1854 St. Louis	Charles A. Pope, Missouri	1888 Cincinnati	A. Y. P. Garrett, District of Columbia
1856 Detroit, Michigan	Zina Pitcher, Michigan	1889 Newport, Rhode Island	W. W. Dawson, Ohio
1857 Nashville, Tennessee	Paul F. Eve, Tennessee	1890 Nashville, Tennessee	L. M. Moore, New York
1868 Washington	Samuel D. Gross, Pennsylvania	1891 Washington	W. T. Briggs, Tennessee
1872 Philadelphia	D. W. Yandell, Kentucky	1892 Detroit	H. O. Mery, Massachusetts
1876 Philadelphia	J. Marion Sims, New York	1893 Milwaukee	Hunter McGuire, Virginia
1878 Buffalo	T. G. Richardson, Louisiana	1895 Baltimore	Donald MacLean, Michigan
1880 New York	Lewis A. Sayre, New York	1898 Denver	Geo. M. Sternberg, U. S. Army
1881 Richmond, Virginia	John T. Hodgen, Missouri	1899 Columbus, Ohio	J. M. Matthews, Kentucky
		1900 Atlantic City, New Jersey	W. W. Keen, Pennsylvania
		1901 St. Paul	C. A. L. Reed, Ohio
		1902 Saratoga Springs, New York	John A. Wyeth, New York
		1905 Portland, Oregon	L. S. McMurtry, Kentucky
		1907 Atlantic City, New Jersey	Jos. D. Bryant, New York
		1908 Chicago	H. L. Burrell, Massachusetts
		1911 Los Angeles	John B. Murphy, Illinois
		1915 San Francisco	William L. Rodman, Pennsylvania
			Albert Vander Veer, Albany, New York
		1916 Detroit	Rupert Blue, United States Public Health Service
		1917 New York	Charles H. Mayo, Minnesota
		1918 Chicago	Arthur D. Bevan, Illinois
		1920 New Orleans	W. C. Braisted, U. S. Navy

Year and Place of Meeting	President
1925 Atlantic City	William D. Haggard, Tennessee
1927 Washington, District of Columbia	Jabez N. Jackson, Missouri
1929 Portland, Oregon	Malcolm L. Harris, Illinois
1931 Philadelphia	E. Starr Judd, Minnesota
1932 New Orleans	Edward H. Cary, Texas
1933 Milwaukee	Dean Lewis, Baltimore
1936 Kansas City, Missouri	James Tate Mason, Washington
1937 Atlantic City, New Jersey	C. G. Heyd, New York
1938 San Francisco	Irvin Abell, Kentucky
1941 Cleveland	F. H. Lahey, Massachusetts

Of course some of those listed as surgeons in the earlier years were men who practiced also to a considerable extent in the general field of medicine, but all of them certainly gave of the majority of their time for surgical work.

The presidential addresses of these physicians before the American Medical Association did much to stimulate and formulate the advancement of surgery in the United States. They were concerned not only with problems of surgical technic but also largely with the special ethical problems that concern the surgeon, as well as with the improvement of the teaching of surgery and of the integration of surgery into all of medical practice.

THE SECTION ON SURGERY, GENERAL AND ABDOMINAL

The article by Dr. Arthur W. Allen, elsewhere in this issue, indicates the contribution that has been made by the Section on Surgery, General and Abdominal, of the American Medical Association, to the advancement of the science of surgery in this country. From the very first that Section has been a forum to which physicians who were especially interested in surgery could come for the exchange of views. Here also there was opportunity not only for the surgeon who qualified by membership in leading surgical organiza-

tions but also for the general practitioner who devoted himself largely to surgical problems and who found it necessary, in a life of service in a less well-settled area, to participate in other aspects of medical practice.

THE JUDICIAL COUNCIL

One of the most significant functions of the American Medical Association has been its contribution to the standardization and advancement of the ethical attitudes concerned in surgery. There has been hardly a session of the House of Delegates, since it became the official body of the American Medical Association charged with the establishment of policy, in which considerations of such matters have not occupied much of the attention. The Principles of Ethics of the American Medical Association are, of course, specific in their condemnation of solicitation of patients or procurement of patients by indirect advertising. These Principles, furthermore, establish carefully the proper relationship that must exist between the physician in charge of the patient and his consultant. They define contract practice, and they state clearly: "When a patient is referred by one physician to another for consultation or for treatment, whether the physician in charge accompanies the patient or not, it is unethical to give or to receive a commission by whatever term it may be called or under any guise or pretext whatsoever." Again and again in its considerations the Judicial Council has reemphasized this high principle. Indeed in 1924 it made a very special pronouncement on the subject, in which it said:

"DIVISION OF FEES"

"Whispered reports and even open statements to the effect that the practice of fee splitting prevails in many places have been heard with increasing frequency during the last year or two. Since the last meeting of this House of Delegates at least two signed communications regarding this subject have come to the Council which deserve

special mention. Each of these makes the point that it is or may be possible that county societies having jurisdiction cannot take action to correct the evil of fee splitting because enough of the members of these societies indulge in the practice to prevent such action. One of the communications referred to came from a Western city, the other from a Northern state. It is contended that, because of the impossibility of securing corrective action by county societies, the American Medical Association should act to investigate existing conditions, expose whatever is found that is reprehensible, and create a situation whereby members of county societies who engage in the practice of dividing fees would be forced out of membership.

"The Judicial Council does not know that the practice of fee splitting prevails generally to anything like the extent indicated by the letters and rumors that have come to the attention of the Council and which purport to describe the situation in the communities from which these came. Moreover, the Council earnestly hopes that the conditions described as existing in those communities have been exaggerated and overstated. As has been done in former reports, however, the Council wishes to record its condemnation of this pernicious practice wherever it may be found, and to urge component societies and constituent associations to purge their membership of any who wilfully refuse to desist from such practice, the continuance of which can only bring dishonor and reproach on the medical profession. So far as its power extends and its jurisdiction reaches, the Judicial Council will undertake to deal with any specific cases which may be presented to it and to render judgment in any cases in which necessary evidence for conviction is put before the Council. It is not felt, however, that the American Medical Association, through any of its established agencies, should go into territory within the primary jurisdiction of any of its units of organization for the purpose of discovering facts that could be obtained only on the evidence

of members of component societies, which are specifically charged with the duty of maintaining the honor of the profession and which have duly constituted machinery for bringing transgressors to account.

"The Council suggests that, when a county society is found to enroll so many fee splitting, or otherwise unethical, members as to render it impossible for that society to enforce the ethical standards of the medical profession, in accordance with the laws of our medical organizations it then becomes the duty of the state councilor, whose district embraces such society, to bring the situation before his state board of councilors and have the charter of such recalcitrant society annulled and in its place to have issued a new county society charter, in the name of well known ethical physicians of such county, in order that a society with ethical standards may be organized and maintained."

Especially important also has been the work of the various sections of the American Medical Association and of the House of Delegates in the cooperation which they have given to the setting up of the boards for the examination and certification of young men who have qualified as specialists. In this work the various agencies of the Association especially concerned with surgery have had a very large part.

THE SPECIAL COUNCILS

Incidentally, every one of the councils of the American Medical Association, including particularly the Council of Medical Education and Hospitals, the Council on Pharmacy and Chemistry, and the Council on Physical Therapy, has on occasion given consideration to problems in the field of surgery. The Council on Pharmacy and Chemistry has made special reports on antiseptics and on sutures. Indeed, it led in the establishment of a procedure whereby government agencies responsible for maintaining standards of foods and drugs would also be concerned with standards for sutures.

The Council on Medical Education and Hospitals has made independent investigations of hospitals and more recently has entered a cooperative effort with the Division of Hospitals of the American College of Surgeons in the standardization of hospitals.

The Council on Physical Therapy has been especially concerned with the development of various devices used in surgery, particularly, of course, the x-ray and instruments for electric coagulation and dissection.

More recently the Council on Industrial Health has been making independent investigations on health in industry and has given special attention to the problem of first aid and the care of the injured in accidents.

Thus the American Medical Association has been through the years an organization in which surgery, both in its social relationships and in its practice, has been integrated with the entire medical cosmos.

ARCHIVES OF SURGERY

In 1920, the Board of Trustees of the American Medical Association took action establishing a periodical, the *Archives of Surgery*, in order to complete the list of periodicals in special fields of medicine, which already included publications in internal medicine, diseases of children, neurology and psychiatry and some other fields. It was determined at that time that the *Archives of Surgery* was not to be particularly in competition with journals of surgery already in existence, and the task of the editor then selected to head this publication, Dr. Dean Lewis, was to develop an organ which would be concerned

primarily with the field of surgical research, investigation and education. It was proposed primarily to enlarge the surgical horizon and to assist in establishing surgery on a sounder basis. Since the publication of the first issue in July 1920, which began with a cooperative article on splenectomy prepared by Dr. Harvey Cushing and Dr. W. G. MacCallum, the *Archives of Surgery* has held a high place in the field of medical letters. Its original contributions have been so significant that it has been on many occasions the most frequently referred to in periodical literature of all publications in the field of surgery.

In 1920, when the *Archives of Surgery* was established by the American Medical Association, there were but two important periodicals in the surgical field. Then the space available was hardly sufficient for the publication of all contributions of value. The highly technical character of much of the material which appeared in the *Archives of Surgery* tended to divert attention to some extent from the *Archives* to other surgical publications which more particularly stressed contributions in the field of clinical surgery.

Following the serious illness of Dr. Dean Lewis, the Board of Trustees determined in 1939 to expand the editorial board of the *Archives of Surgery* and to modify the nature of its contents to make it fulfill more completely its original purpose. Dr. Waltman Walters of Rochester, Minnesota, has therefore served since July 1939 as editor-in-chief of the *Archives of Surgery*. Publication is now in its fortieth volume and contributes each year more than 2,000 pages to the available surgical literature of this country.



THE INFLUENCE OF THE AMERICAN MEDICAL ASSOCIATION ON SURGERY

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DR. N. S. DAVIS, of Chicago, was greatly interested in the organization of the American Medical Association. In 1855, he published the early history of the Association, describing its formation following a preliminary first meeting held in New York in 1846. The next year at Philadelphia, the organization was completed and the first annual meeting of the Association was held in Baltimore in 1848. Although at this and several subsequent meetings improvement in medical education and reports on epidemic diseases were the chief topics of interest, we find that many of these early dissertations dealt with clinical subjects.

Beginning in 1851, scientific contributions were submitted to special committees for appraisal and each year a prize was given for the best essay. Apparently, the first paper on a surgical subject to rate this distinction was by Dr. Washington L. Atlee of Philadelphia on "The Surgical Treatment of Certain Fibrous Tumors of the Uterus, Heretofore, Considered Beyond the Resources of the Art." This was at the sixth annual meeting held at New York in 1853. One might consider this to be the beginning of a steady, continuous and ever-increasing influence of the American Medical Association on the development of surgery in this country. In 1859, at the twelfth annual meeting, a resolution was adopted to divide the scientific sessions into four sections. These were (1) anatomy and physiology, (2) chemistry and materia medica, (3) practical medicine and obstetrics, and (4) surgery. Subsequently, there were numerous changes in the sections from time to time according to the interests of the members and scientific advances.

Soon the section on surgery and anatomy was established and continued as such until 1908; after which time it became Surgery, General and Abdominal. From this section various surgical specialties were set apart from time to time as separate sections; the first of these comprised Ophthalmology, Otology and Laryngology in 1878. There was more latitude in surgery in those early days than exists today but it was obvious then that specialties were well on their way. However, interests are still sufficiently broad to combine occasionally sectional meetings for a portion of the program with great success. Often members are faced with conflicting desires to hear papers that are being presented in different sections at the same time. On the whole, these divisions of the huge field of medicine have worked out satisfactorily.

This Association gave the first opportunity for the discussion of scientific subjects before groups of physicians from all parts of the country. Long before surgical societies of national scope were organized, the surgical section of the American Medical Association demonstrated the importance of such meetings. Early reports of new surgical procedures, changes in surgical technic and anesthesia, and statistical data on end results have accounted for the steady increase in attendance. Members not able to attend these meetings anxiously await the published reports in the Journals of the Association. This effort on the part of American physicians to keep abreast of the times, for the sake of their patients, is a characteristic of which we are justly proud. Not only the teachers of surgery in medical schools and clinics may participate, but frequently papers of great importance have come from surgeons in isolated communi-

ties. There is also an opportunity for the younger man to make a contribution to science before he is eligible for membership in many surgical societies.

THE PROBLEM OF APPENDICITIS

As one reviews the transactions of the Section on Surgery, many impressive periods in the development of this art are brought to light. Before this section, the appendicitis problem has held the limelight in the various eras of our knowledge of the subject. The presentation of Fitz, who first described the disease more than fifty years ago, was quickly followed by much discussion regarding the proper treatment. That it soon became recognized as a surgical entity is not surprising, since it was easily demonstrated in those early days that removal of the offending appendage was attended by a high percentage of satisfactory results. Dr. John B. Deaver presented many papers on this subject and he with many others of his time was instrumental in bringing about a standardization of the management of the varying manifestations of this disease. A great number of men reported their experiences in this field, which developed so rapidly, in such a manner as to bring about a certain amount of clarity concerning the situation. As surgical and diagnostic methods improved and the careful analysis of large groups of patients became available, there has been a tendency to keep the subject of appendicitis and its treatment in the foreground. The reason for this constant vigil over such a widespread disorder is the fact that every year there are more deaths from this cause in the United States of America than from any other except cancer. When one considers that most of the victims of appendicitis are in the younger generation, it seems all the more reasonable to devote as much time as can effectively be spent in discussing the reasons for our failures in this group of patients. Doubtless, until the mortality rate has reached a much lower level than at present, there will continue to be one or

more presentations on the subject at each annual scientific assembly.

THE MANAGEMENT OF GOITER

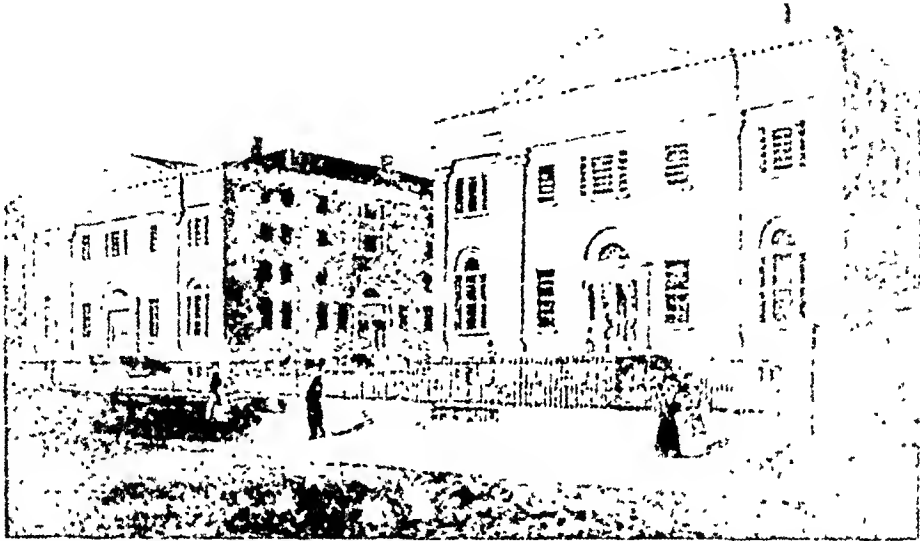
The development of the surgical management of goiter is an interesting section of the American Medical Association meetings. Medicine and surgery collaborated on the standardization of the treatment of thyroid diseases. Marine made his contribution to the subject of endemic goiter and by succeeding legislation has practically eliminated this type of disease in the Great Lake districts. To the private clinics must be given the credit of treating large groups of patients in a certain manner and reporting end results. This type of report was extremely valuable in standardizing the treatment of many disorders and is spectacularly true in the treatment of goiter. Dr. W. S. Halstead was a pioneer in this field of surgery in this country and his basic principles, regarding the importance of the parathyroid bodies, revolutionized the whole problem of thyroid enucleation. At a symposium on the subject more than twenty-five years ago, the groundwork was laid for the study of goiter by a special commission. Gradually, a satisfactory understanding of thyroid diseases has come about.

GASTROINTESTINAL SURGERY

Gastrointestinal surgery went through a most interesting and varied developmental period. At a time when the peptic ulcer victim felt doomed to a life of dyspepsia, gastroenterostomy became the great panacea for all stomach trouble. John B. Murphy invented his famous button to facilitate a union between one segment of the gastrointestinal tract and another. In emergency cases, this proved a great boon to the surgeon in the early days when sutures and suture material were not well understood. The immediate relief following gastroenterostomy in peptic ulcer created such a widespread adaptation of the operation that it has required more than twenty-five years to evaluate it properly. The

gastroenterologist came into the picture and, by a careful management of the patient from hygienic, dietary and medical

bloodless manner that allows him to carry out extensive operations with little or no shock to his patient. Only recently has a



The University of Pennsylvania
The Medical Building (right) and College Hall (left) at Ninth and Chestnut Streets,
which replaced the Presidential Mansion.

measures, has taken over this group of patients. Surgery is now being resorted to in the complications of this disorder and in a small percentage of cases particularly resistant to palliative management. Experience in operative procedures on the stomach accumulated and the type of operation has gradually been adjusted to the character of the lesion.

ANESTHESIA

Anesthesia, being so vital to the development of surgery, was always a subject of interest in these sectional meetings. Contributions of great importance are reported in the transactions. The proper evaluation of anesthetic gases has been brought before the surgical profession as rapidly as experience in this field could be obtained. The use of local anesthesia by infiltration, field block and the spinal canal has become widespread. The safety of these procedures was demonstrated by animal experimentation and the danger zones and limitations gradually worked out. The surgeon is no longer hampered by the fear of inadequate anesthesia and can proceed in a careful,

separate section on anesthesiology been set apart from surgery. The further researches of this important section will be of great value to humanity and appreciated by the surgeon.

BLOOD TRANSFUSION

The development of blood transfusion has been an interesting surgical procedure. The early direct methods of joining an artery of the donor to a vein of the recipient required a delicate operative maneuver. This has gradually been replaced by more simple methods. Whole blood collected in large paraffined glass tubes was a great advance. Citrated blood finally became generally adopted and is still in use in most clinics. Many ingenious mechanical devices for blood transfusion were brought out and some of them have found favor. Now the development of blood and plasma banks are popular. The heated discussions in the sectional meetings on the advantages of the whole blood method over citrated blood and vice versa now seem irrelevant but it is only by such interchange of experiences that advances can be made.

FRACTURES

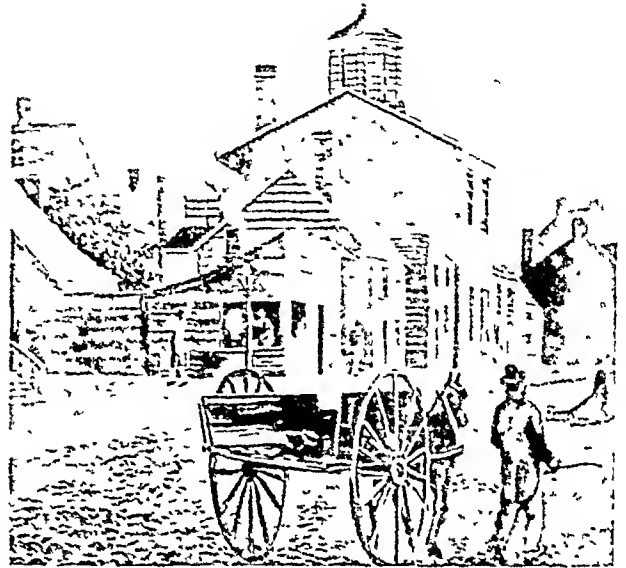
The general surgeon is still called upon to treat fractures of the bony skeleton. He relinquishes his interest in this field to the orthopedic surgeon with great reluctance. Standardization of treatment of these lesions is not easy to bring about. Doubtless, there are many useful methods. Some are better adaptable to the general surgeon in a rural community, while others are suited to a large urban clinic. The end results are not always perfect in either case but there has been a steady, gradual improvement in the treatment of fractures throughout the country. Contributions on the subject are still offered in the surgical as well as in the orthopedic sections. In 1939, the two sections combined their programs for one session to the enlightenment of all concerned.

THE CANCER PROBLEM

All branches of medicine have contributed to the cancer problem. From the hopeless viewpoint held only a few decades ago, we have come a long way. Surgeons have welcomed all aid in this field but still must use their skill in the treatment of many forms of this disease. Radiologists have demonstrated that they can often produce a better result with less mutilation than the surgeon. Gradually, there has come about a combined effort in treating the lesion in certain areas of the body. There are still many questions to be settled in this regard but there is a cooperative spirit that will bring about a better situation. Cancer of the breast, when treated by radical operation, can be cured in a specific percentage of cases. Early presentations on this subject by Halstead, Rodman and Richardson are as sound today as they were a quarter of a century ago. Radiation may supplant surgery in this field of cancer and now is looked upon as an important adjunct.

Cancer of the gastrointestinal tract has been one of the chief topics of discussion in many of our meetings. The increase in the

knowledge concerning this disease has brought about a better understanding of its development, its early manifestations,



Medical School of The University of Pennsylvania from 1765 to 1802 known as Surgeon's Hall.

the mode of its spread, and consequently, its complete extirpation. The improvement in diagnostic methods, the preparation of the patient, anesthesia and surgical technique have made it possible to cure many of these patients. A free interchange of ideas and the careful study of end results have brought about some standardization of the methods at our disposal. It is obvious when one looks over many of the presentations on this subject that there are many useful procedures. The conditions under which he works and his adaptability to certain types of surgery make it necessary for each surgeon to use a method that in his hands gives a satisfactory result. Too much has been said about the terrible afflictions of a permanent colostomy, the result of which has spelled the doom of many useful citizens. Thousands of happy people, leading otherwise normal lives, are colostomy patients. Since operation for cancer of the large bowel and rectum offers approximately a 50 per cent chance for a five-year cure and often a worth while shorter respite, it is surprising that there can still be any hesitation on the part of the profession to offer relief to this group of patients.

NEUROSURGERY

Surgery of the brain and spinal cord has developed almost entirely in the past three decades. Many of Harvey Cushing's earlier experiences in this field were reported before the surgical section of the Association. Although now there are many neurosurgeons who devote their entire time to this specialty, we find that the general surgeon is still interested in the subject. This is true of many other subdivisions, particularly genitourinary, gynecologic and thoracic surgery. All were begun by general surgeons and the frequent overlapping of interests, at present, is beneficial. One cannot become limited to a viewpoint so narrow that more important aspects of the problem are lost.

Early surgery was of the emergency type. The repair of traumatic wounds, amputations and the drainage of abscesses comprised the major part of the surgeon's work. As knowledge of pathology and bacteriology increased along with safe anesthesia, operations of an elective nature rapidly developed. Removal of tumors and the repair of hernia were among the earlier

procedures successfully attempted. As experience grew through trial and error and finally by animal experimentation, there gradually came about a logical approach to remediable lesions in all parts of the body. Progress was slow in some fields but as new developments were brought to light, they were at once subjected to criticism which resulted in their proper evaluation.

One cannot help but feel that this last half century has been a most alluring one from the surgeon's viewpoint. So much has been accomplished that the medical student often wonders whether there is anything left for him in surgery save to become an excellent technician. Little does he realize that, although a certain standard of perfection does exist, there are endless important problems in this field as yet unsolved. That fifty years from now our successors may look with some amusement on our 1941 state of knowledge is the hope we hold for the future of humanity.

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SIGNIFICANCE OF THE AMERICAN COLLEGE OF SURGEONS TO PROGRESS OF SURGERY IN AMERICA

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IN the light of the present status of the American College of Surgeons, it seems incredible that its launching by Franklin H. Martin and his associates in 1913 should have brewed the tempest it did. The tempest, however, is part of the story, and perhaps one of the reasons that make the story of the College so interesting to tell and to hear is that the reactions of the characters who figured in it were so violent, either in favor of or against the organization.

Blasts like the following warmed the pages of professional publications in 1913 and 1914:

"Here it is at last, a full-blown attempt by would-be conspicuous members of the home profession to engraft upon the democratic tree of free American medicine a royal sprout of would-be aristocracy from 'Old London Town.' . . . But the great American profession has a temper all its own, founded upon self-respect, and a democratic love of fairness, and a dislike for all counterfeits. How well this latest attempt to build up an oriental oligarchy for the purpose of controlling honors, titles, offices and, incidentally, business, is to be received by this progressive profession in the West, remains to be seen. There is more than an intimation in the air that many a man with the label of F.A.C.S. on him will be ready eventually to sell it very cheap."

Another surgeon ended a long communication to an editor with the following paragraph:

"Some unthinking surgeons, dazzled by the display of red fire and confused by the discharge of blank cartridges, have been actually stampeded into joining this college at its recent inauguration in Chicago, fearing lest they

might otherwise lose out. A good many more, who had been almost persuaded, received enlightenment in time, and wisely withheld their applications."

The tempest has long since been quieted. Eagerness to co-operate with other organized groups was shown by the College, and in the years since its founding, it has had their help in waging an earnest fight to further the aims stated by John M. T. Finney of Baltimore.

"To put down corruption and graft, to cleanse our professional escutcheon of the foul blots with which it is stained, to elevate the ideals and the whole tone of the profession, to encourage research and study, to increase the efficiency and to raise the standard of every individual surgeon."

Blessed with aggressive leaders and stimulated by the imagination and tireless energy of Franklin H. Martin, the American College of Surgeons has proved itself to be one of the most potent forces for progress in surgery today.

The College developed as the logical sequence to a series of events, a recounting of which properly belongs in its story, since only in this way can the spirit of the founders and the manifold activities in which it has engaged be understood.

1. *Surgical Journal Edited by Active Surgeons Initiated.* The first of the preliminary events was the starting on July 1, 1905, of *Surgery, Gynecology and Obstetrics*, as a result of Dr. Martin's conviction that there was a place for a practical journal for practical surgeons, edited by active surgeons. Nicholas Senn headed the Editorial Board, with Dr. Martin as Managing

Editor and Allen B. Kanavel as Associate Editor. The immediate success of this publication was proof that "the profession preferred to receive information directly from practicing surgeons rather than from non-practicing editors." This conclusion led logically to the idea that "it would be far better to have a practicing surgeon *demonstrate* his work than to have him tell about it."

2. *Journal Invites Its Subscribers to Clinics.* Following this conviction with action, the Editorial Board of *Surgery, Gynecology and Obstetrics* arranged for a group of surgical clinics in Chicago to which it invited its subscribers, from November 7 to 19, 1910.

"It was an innovation," commented Dr. Martin, "that the academic orators and medical politicians watched with amusement that they did not conceal; but it stirred in the minds of practical surgeons a hope that the advantages of the Society of Clinical Surgery (founded in 1903 by a select group) were now to be extended to all progressive specialists. At any rate, many of them evidently decided that they would see for themselves, as thirteen hundred men registered on the opening day."

Those in attendance at the clinics expressed a desire to perpetuate them. The keynote was struck by John B. Murphy, then and always Dr. Martin's staunch supporter:

"Hearing papers and reading papers is one thing. Seeing men do things is another. We all know that no such benefit can be derived from hearing papers read as one can obtain from seeing the work done right before us. When you see and hear it in the latter way, it is a part of yourself. When you hear it read, it is still the author's although a small part of it has been absorbed by yourself."

3. *Clinical Congress of Surgeons of North America Organized.* There followed then in logical sequence a meeting on permanent organization, on November 18, 1910. At this meeting Albert J. Ochsner was elected president following his nomination by John B. Murphy; and the organization was formally completed and named the Clinical

Congress of Surgeons of North America. The second Congress was held in Philadelphia, November 7 to 16, 1911, with fifteen hundred doctors enrolled, and the third in New York, November 11 to 26, 1912, with twenty six hundred doctors registered during the first two days and hundreds more in attendance who had not registered.

At a meeting with the New York committee to prepare for the third Clinical Congress, it became apparent that it would be necessary to limit attendance at clinics to registered members, and to choose wisely the clinics and clinicians who were to be scheduled for presentation.

4. *Idea of Organization to Control Attendance Conceived.* Event number four was the conception by Dr. Martin of the plan for a new organization through which definite qualifications for membership would be established. This plan, presented by him at the business meeting of the Congress on November 15, 1912, was enthusiastically endorsed by Dr. Murphy, and unanimously approved by the two thousand surgeons present.

5. *Idea of Qualifying Purpose of Organization Broadened.* The fifth development was recognition that the need for qualifying surgeons in general was far more important than simply to control attendance at the Clinical Congress. The necessity for approving hospitals and clinics for the common good of both surgeon and public was paramount to selection of creditable institutions in which to hold the clinics. Out of considerations such as these, and with the support of John B. Murphy and Edward Martin, Dr. Martin drew a plan for the establishment of an American College of Surgeons which involved the setting of professional, ethical and moral standards for membership. A special degree, documentary evidence of such a degree and publication of membership lists were among the original proposals approved by the Clinical Congress. A committee of twelve was appointed to proceed with the organization. These men were:

Edward Martin, Philadelphia
 Emmet Rixford, San Francisco
 John B. Murphy, Chicago
 Rudolph Matas, New Orleans
 Albert J. Ochsner, Chicago
 Charles H. Mayo, Rochester
 Frederic J. Cotton, Boston
 George Emerson Brewer, New York
 John M. T. Finney, Baltimore
 Walter W. Chipman, Montreal
 George Crile, Cleveland
 Franklin H. Martin, Chicago

6. *Clinical Congress Initiates Hospital Standardization.* The Clinical Congress at this same meeting (November, 1912) acted on a proposal by Allen B. Kanavel that was destined to develop into one of the most important activities of the future college. Dr. Kanavel's proposal was:

"Some system of standardization of hospital equipment and hospital work should be developed, to the end that those institutions having the highest ideals may have proper recognition before the profession and that those of inferior equipment and standards should be stimulated to raise the quality of their work."

The committee appointed to carry out the spirit of this resolution was headed by Ernest Amory Codman of Boston, who had already gone on record as favoring standardization of hospitals. Dr. Codman made progress reports to the Clinical Congress in 1913 and 1915.

7. *Clinical Congress Initiates Public Education in Cancer Control.* Of far-reaching importance, both as presaging an activity of the future College and as influencing progress in the fight against cancer, was the creation at this same 1912 Congress, at an evening program given over to a consideration of cancer of the uterus, of a committee of five, with Thomas S. Cullen of Baltimore as chairman, to wage a campaign of publicity to acquaint the people of the country with the fact that in the early stages of cancer a large proportion of patients can be cured by operation. Commenting on the creation of this committee, an editorial in *Surgery, Gynecology and Obstetrics* in January, 1913, said in part:

"The committee was explicitly instructed to write or have written popular articles on the subject of cancer and to have these published in the daily press, the weekly or monthly magazines, or journals as was deemed most expedient. In the course of a year it is hoped that the people of the United States will be able to find, in the current literature that they are accustomed to read, simply written articles on every variety of cancer about which they should have a clear knowledge."

The manner in which this campaign was carried forward is a striking example of effective co-operation. The American Gynecological Society also had a committee on cancer. The following spring this committee presented to certain public spirited women of New York the need of a national organization whose sole purpose would be education of the public. The idea having been favorably received by the women and prominent surgeons, the Committee presented it at the Congress of Physicians and Surgeons in Washington, the week of May 4. Following the endorsement of this body, the American Society for the Control of Cancer was organized on May 22, 1913, to conduct the same kind of campaign with which the Clinical Congress had charged its Cancer Committee. Thereafter, the Society and Committees from the American Gynecological Society, the Clinical Congress (later the American College of Surgeons), and the American Medical Association co-operated to further this work and are doing so to this day.

THE GROUNDWORK FOR THE COLLEGE IS LAID

At the Clinical Congress of 1912, therefore, the shape, aims and individuality of the future American College of Surgeons appeared in somewhat nebulous form. As a clinical surgical society, it had the Clinical Congress with its yearly sessions, including practical demonstrations and scientific papers. As an accrediting board, the proposal was made to establish an American College of Surgeons. Its desire to stimulate betterment of hospital facilities for surgeon

and patient was evidenced in the hospital committee appointed by the Congress. The interest in clinical research was presaged in the cancer meeting. Responsibility to the surgeon and prospective surgeon was shown in the desire to improve hospitals, and thereby to increase educational facilities and opportunities. Responsibility to the public was expressed in the intention to publish lists of accredited surgeons, to educate the individual to seek early treatment for cancer and to establish standards of hospital service. To one studying the College today, these early stages assume great significance both as indicative of the broad vision of the founders and of the vitality with which the initial purposes have been carried out and sustained.

With acute foresight, Franklin Martin realized that opposition to such an organization would develop regardless of its merit or the sincerity of its founders. With the authority of the Clinical Congress and the Committee on Organization, an Illinois Charter was obtained November 25, 1912, and Doctor Martin devoted much of his time from then until the following May in presenting the plan to some five hundred surgeons in the United States and Canada. His accounts of these meetings as they appear in his "The Joy Of Living" make interesting and stimulating reading and give insight into the sincerity and persistence of the man. It would appear from his accounts that the College and the ideas it represented were enthusiastically supported and appreciated by the younger members of the surgical profession of his day, and that the encouragement and support of many men of vision in the older group gave the project authority.

THE COLLEGE IS FOUNDED

Of the 500 surgeons invited to serve as founders, 450 came to the meeting at Washington, D. C., on May 5, 1913, at which were presented the plans for the organization, the proposed by-laws and the charter. The by-laws were accepted, resolu-

tions were passed, and the following officers were elected:

John M. T. Finney, Baltimore, President
Walter W. Chipman, Montreal, Vice President
Rudolph Matas, New Orleans, Vice President
Albert J. Ochsner, Chicago, Treasurer
Franklin H. Martin, Chicago, Secretary General

The original Board of Governors, as provided in the by-laws, consisted of the surgeons invited by the Organization Committee to serve as Founders of the College. The Governors elected from among their number the following Regents:

George E. Armstrong, Montreal
George E. Brewer, New York
Herbert A. Bruce, Toronto
Frederic J. Cotton, Boston
George Crile, Cleveland
John M. T. Finney, Baltimore
William D. Haggard, Nashville
Edward Martin, Philadelphia
Franklin H. Martin, Chicago
Charles H. Mayo, Rochester
Robert E. McKechnie, Vancouver
John B. Murphy, Chicago
Albert J. Ochsner, Chicago
Harry M. Sherman, San Francisco
Charles F. Stokes, Washington

These with vice-presidents, Chipman and Matas, constituted the first Board of Regents.

FEE-SPLITTING PROHIBITED

It is significant that at the meeting which made the American College of Surgeons an assured fact and even before it had begun to function, a declaration against the division of fees was adopted as a cardinal principle. So strong was the feeling that the College should fight this practice, that Dr. Martin had to urge that this battle be conducted as part of, but not dominate, the positive purpose to "elevate the standard of surgery."

The stand against fee-splitting has been firm and probably no one ethical qualification of a candidate receives so much scrutiny as that which has to do with the division of fees. While important in itself,

this consideration serves also to focus attention on the fact that in judging qualification for fellowship the ethical standing receives equal consideration with the professional. The College also has a lever against fee-splitting even outside its fellowship. It has made one of the conditions of its approval of hospitals the enforcement of rules and regulations against division of fees by any members of the staff.

EARLY YEARS

The first convocation, at which 1,059 surgeons were admitted to fellowship, was held in the Gold Room of the Congress Hotel in Chicago on November 13, 1913, and the ritual and procedure were patterned largely after similar formalities of the Royal College of Surgeons of England, Scotland and Ireland, which had, in so far as conditions were comparable, served as the model for the American College. Sir Rickman J. Godlee, of London, then president of the Royal College of Surgeons of England, brought official greetings of that body and delivered the Fellowship Address. He received the first honorary fellowship in the new College.

The Clinical Congress was continued more or less independently until 1917, when it was merged with the College which has since controlled it as a self-sustaining activity.

At the first six convocations, a total of 3,795 candidates were received into fellowship. Three main developments stand out in this period, as follows:

1. The plan for a hospital program began to take form.

2. In 1915, an International Committee on Standards was formed to consider ways and means to create, (a) supplementary and graduation training for surgeons; (b) legislative enactment and other means to prevent dishonest practices; and (c) enactment of laws to protect the public against untrained surgeons.

3. Pre-war preparations and then the war itself checked activities and imposed emergency planning and work.

The Sixth Convocation held in Chicago, October 26, 1917, was a great military gathering, hundreds of the medical officers in the service of the Army and Navy being present on leave. The Fellowship Address was delivered by Sir Berkeley Moynihan, Colonel in the Royal Army Medical Corps of England. Doctor Martin had deliberately planned to utilize this occasion for a war meeting to demonstrate the country's further need for medical officers. Again he enlisted the aid of the spectacular to create an impression and was successful. Present were the Surgeons General of the Army, the Navy and the Public Health Service. President Wilson sent a telegram of greeting, and Secretary of the Navy, Josephus Daniel, was a surprise speaker. A martial note was also given by John Philip Sousa and his band from the Great Lakes Naval Training Station.

Doctor Martin was one of the seven members appointed by President Wilson to the Advisory Commission of the Council of National Defense. He was interested in the establishment of medical advisory boards and in campaigning for the enrollment of medical officers. Ninety per cent of the Fellows of the American College of Surgeons enrolled for war service—40 per cent in the Medical Corps of the United States and Canadian Armies, 10 per cent in the Navy Medical Corps and 40 per cent in the Volunteer Medical Service Corps of the United States. Fellows of the College headed the greater percentage of the forty-two base hospitals organized for service over-seas. Many of these were composed of surgeons and other medical and nursing personnel from one institution, and many of the enlisted men were drawn from the undergraduate body of an affiliated university. The idea for such a unit emanated from Doctor Crile, then a vice-president of the College. Several of these base hospitals reached England and France before any other American soldiers.

Eleven years after the war when time had made it possible to evaluate some of the accomplishments, Merritte W. Ireland,

Surgeon General of the United States Army, in his Inaugural Address as president of the American College of Surgeons, said that the results of the surgery of the war were far better than those of any previous war. He said that despite the fact that two-thirds of the wounds were made by explosive missiles, 90 per cent of the wounded were saved, and that the advances in the treatment of deformities in orthopedic, plastic and head surgery could scarcely be estimated. We may be sure in retrospect that not a little of this result praised by the Surgeon General was attributable to the good fortune that made American surgery an organized unit at the time war struck.

As an aftermath of the war, another of those dramatic events occurred that lend color to the history of the College. At the tenth session of the Clinical Congress held in Montreal in 1920, a committee representing the consulting surgeons of the British armies presented to the American College of Surgeons the Great Mace designed to tell in a symbolic way of the close union between British and American surgery and of the ties which unite Great Britain to Canada and to the United States.

REPRESENTATIVE CHARACTER OF THE COLLEGE

It would be impossible to separate the story of the progress of American surgery since 1913 from that of the progress of the American College of Surgeons. One reason for this is that those who have led the College have always had a larger purpose than advancing that organization; their spirit has been one of service to surgery. Another reason is that the organization is in a large degree a compound of other surgical societies, and its activities are interwoven with those of all groups working to advance educational, ethical, scientific and humanitarian standards of medicine. This heterogeneous character is shown by the fact that twenty surgical associations and societies are entitled to nominate each year one Fellow to serve for

the three years as a candidate for the Board of Governors. These are:

American Surgical Association
Surgical Section of the American Medical Association
Section on Obstetrics, Gynecology, and Abdominal Surgery of the American Medical Association
American Gynecological Society
Southern Surgical Association
Western Surgical Association
Section on Surgery of the Canadian Medical Association
American Association of Obstetricians, Gynecologists, and Abdominal Surgeons
American Orthopedic Association
American Academy of Orthopedic Surgeons
American Association for the Surgery of Trauma
American Association of Genito-Urinary Surgeons
American Urological Association
American Laryngological Association
American Ophthalmological Society
American Otological Society
American Institute of Homeopathy
Pacific Coast Surgical Association
Medical Corps, United States Army
Medical Corps, United States Navy

Since the Board of Regents, which controls and manages the affairs and funds of the College, is elected by the Board of Governors, it is obvious that a truly representative organization has been achieved. This is further evidenced by the fact that geographic representation is provided through a policy of having as many governors for each state, province and foreign country as would be proportionate to its number of Fellows. With 150 governors and a fellowship of around 13,000, the representation averages about one governor to each ninety Fellows in a geographical division. The nominations by the surgical societies sometimes unbalance the geographical distribution, but a means of adjustment is provided through the elections from the general fellowship.

THE FELLOWSHIP PLEDGE

The fellowship pledge, little changed from the wording adopted in 1913, is

broadly indicative of the purposes of the organization:

Recognizing that the American College of Surgeons seeks to develop, exemplify, and enforce the highest traditions of our calling, I hereby pledge myself, as a condition of Fellowship in the College, to live in strict accordance with all its principles, declarations, and regulations. In particular, I pledge myself to pursue the practice of surgery with thorough self-restraint and to place the welfare of my patients above all else; to advance constantly in knowledge by the study of surgical literature, the instruction of eminent teachers, interchange of opinion among associates, and attendance on the important societies and clinics; to regard scrupulously the interests of my professional brothers and seek their counsel when in doubt of my own judgment; to render willing help to my colleagues and to give freely my services to the needy. Moreover, I pledge myself, so far as I am able, to avoid the sins of selfishness; to shun unwarranted publicity, dishonest money-seeking, and commercialism as disgraceful to our profession; to refuse utterly all money trades with consultants, practitioners or others; to teach the patient his financial duty to the physician and to expect the practitioner to obtain his compensation directly from the patient; to make my fees commensurate with the service rendered and with the patient's rights; and to avoid discrediting my associates by taking unwarranted compensation. Finally, I pledge myself to co-operate in advancing and extending, by every lawful means within my power, the influence of the American College of Surgeons.

SELECTION OF FELLOWS

The College early overcame the opposition on the score of exclusiveness by demonstrating the sincerity of the announcement by the Board of Regents that it would be the "spirit of the Association to open the fellowship to all competitors in surgery without favor." Applicants for fellowship are thoroughly examined and investigated, not only in respect to professional qualifications, but ethical as well, and a conscientious attempt is made properly to evaluate a man, on the basis of all obtainable data. Applications to

fellowship are studied by Committees on Credentials, consisting of a Central Committee which reports to the Board of Regents and State and Provincial Committees which report to the Central Committee. After examination of candidates' records and references, the Committees make recommendations as to eligibility. There have recently been added in a number of cities and states, Committees on Applicants which personally interview and investigate all applicants before they are considered by the Credentials Committees.

In the beginning, rigid educational requirements could not be enforced. As time has passed the influence of the College, more than any other single factor, has increased opportunities for education and training; and it has been possible to define more specifically the requirements for fellowship, and to raise them from time to time. They now specify graduation from an accepted medical school; a year of internship in an acceptable hospital; at least two years spent as surgical assistant or apprentice (applicants whose medical degree has been obtained since January 1, 1938, must have completed three years of hospital service of which two years have been spent in training in surgery in approved hospitals); seven years after graduation in medicine devoted to special training and to practice; submission of one hundred case records of major surgical work, including at least fifty cases for which the candidate was the responsible surgeon; and approval by the Credentials Committees after determination of the applicant's moral and ethical fitness, by reports of surgeons whose names are submitted by the applicant, and by such other information as the Committees and the Administrators of the College may obtain.

JUNIOR CANDIDATES

A Junior Candidate Group was formed in 1923 at the suggestion of John Wesley Long of Greensboro, North Carolina. The purpose of this group is to bring the younger medical graduates, who intend to

enter the surgical field, under the influence of the ethical and educational standards promulgated by the College. Any legalized practitioner of medicine who has been graduated from an approved medical school for a minimum period of two years, and not more than seven years, and who plans to specialize in surgery may apply. The College requires formal application, other information such as is exacted from the applicant for fellowship and a signed declaration against the division of fees. A Fellow of the College is appointed to act as Counselor to each Junior Candidate endorsed by the Credentials Committee. Members of the Junior Candidate Group are eligible to attend the Clinical Congress and Sectional Meetings of the College. They are acceptable as Fellows only after they have met the requirements for fellowship.

GEOGRAPHIC DISTRIBUTION OF FELLOWS

Doctor Martin makes reference in his book to the fact that the American College of Surgeons is not in Chicago, but in every community on this continent and South America where the Fellows of the College reside and practice their profession. An important factor in decentralization is the holding of sectional meetings, or miniature Clinical Congresses, every year in various groups of states and provinces. These serve to bring together the Fellows and their confrères and those interested or engaged in hospital work.

Surgeons of Canada were among the founders of the College and have always been active in its direction and work. In 1915, a number of Latin American surgeons petitioned for admission to fellowship. The war delayed action, but in 1920, Doctor Martin and William Mayo, then president, made a trip to Latin American countries, visiting the surgeons of Panama, Peru, Chile, Argentina and Uruguay. As a result of this and later visits by representatives of the College, eighteen Latin American countries are now represented, each having its Committee on Credentials, and fellow-

ships have been conferred upon 321 surgeons from Latin America.

MAJOR ACTIVITIES—HOSPITAL STANDARDIZATION

The war interrupted the regular activities of the College, but it also furnished a stimulus to some of them. Among these was Hospital Standardization.

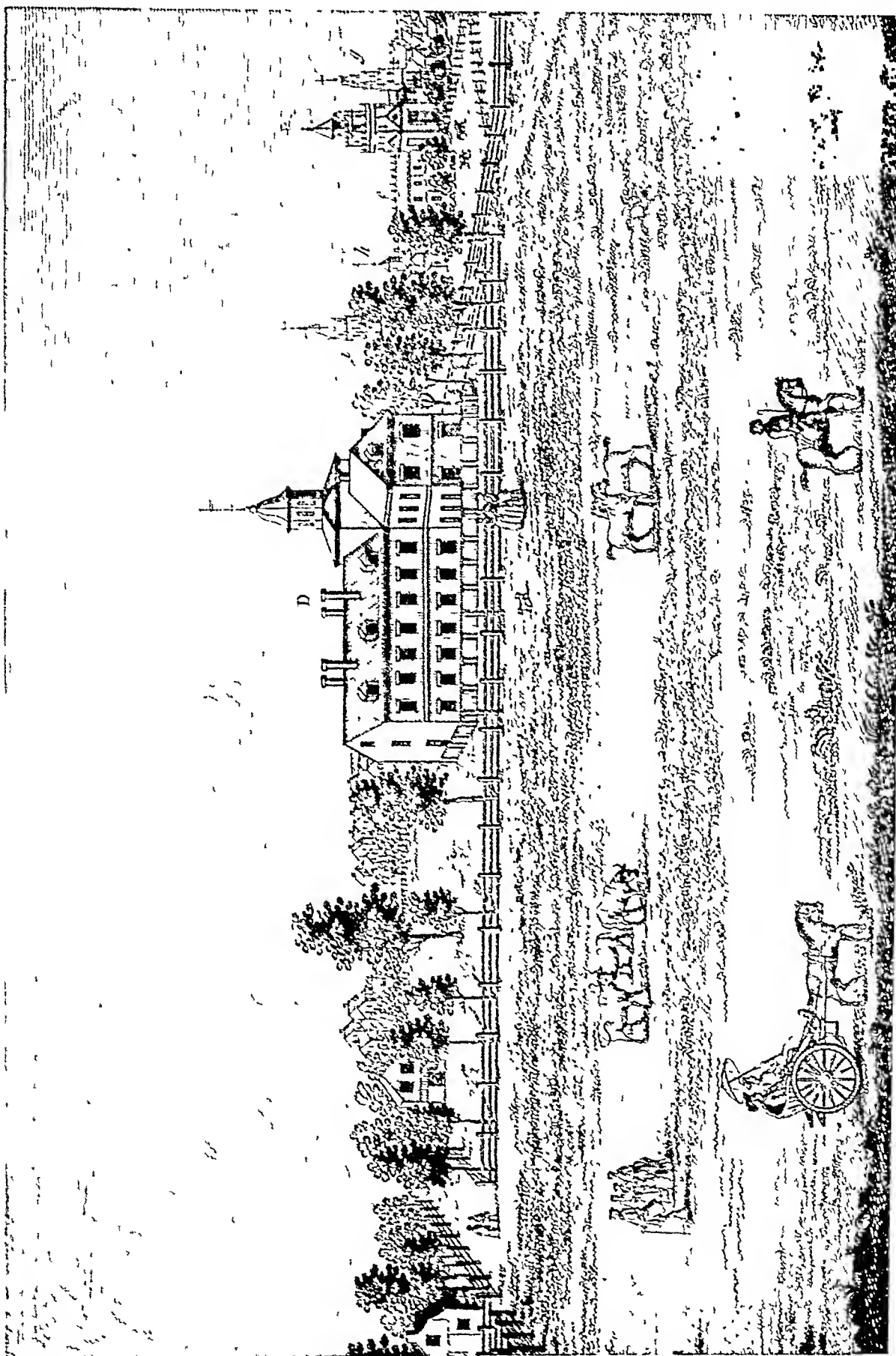
In an article in the 1917-1918 Year Book, the effect of the War on Hospital Standardization was interpreted as follows:

"With some impatience the Fellows of the College looked forward to an active campaign throughout the continent for the betterment of hospitals. Then came the war and its quick effect to vitalize a high ideal of service not only in the profession and among hospitals, but throughout every phase of our national life. In the fluid state of mind thus created, soldiers, sailors, and the general public realized with new force that they are entitled to the best in medical science; and the profession in turn by this awakening was struck with a keener sense of the debt which the practice of medicine demands. Almost in a single morning all shadows of doubt as to whether a continent-wide standardization of hospitals could be entered into with continent-wide good will were cleared away."

The hospital program was endorsed by the American Hospital Association on September 27, 1916, and a committee was appointed to co-operate in its furtherance. The officers of the Catholic Hospital Association, together with His Eminence, James Cardinal Gibbons, also endorsed, on January 11, 1917, the proposed standardization plan and offered their co-operation and aid. Likewise, the Protestant Hospital Association, the Board of Hospitals and Homes of the Methodist Episcopal Church and the Baptist Hospitals gave enthusiastic support.

THE MINIMUM STANDARD FOR HOSPITALS

In March, 1918, after considerable study and analysis, the College distributed to hospitals and the Fellows a bulletin en-



Pennsylvania Hospital Chartered in 1751—Building Designated by the Letter "D" is the Hospital

By Hulet

titled, "Standard of Efficiency for the First Hospital Survey." During the years 1918 and 1919, field representatives visited 671 hospitals of 100 beds or more in the United States and Canada, and of these eighty-nine were approved as meeting the Minimum Standard in 1918, and 198 in 1919.

The program won public notice. "World's Work" assigned a writer, Mr. Hawthorne Daniel, to report upon it, and his article, published in the June, 1920, issue, included the following remarks concerning the Minimum Standard:

"The statement is simplicity itself, and yet, with all of its simplicity it contains just the suggestions that go to make good hospitals of mediocre ones; just the suggestions that lead to the conservation of lives and the elimination of unnecessary operations; just the suggestions that bring about the conscientious care that every patient in every hospital has a right to expect.

"From coast to coast the idea is changing the conditions in hospitals. Everywhere there is the ferment of development, the activity of improvement. In great centers of medical affairs the changes have been startling. In Baltimore, the greatest center of medicine in America, there is not a hospital of 100 beds or more that has not put into effective operation the Minimum Standard.

"In New York and other cities the hospitals have made almost as great an advance. The world of the hospital is changing. An advance normally to be expected in twenty years has come in three. For this opinion I am indebted to President Henry E. Pritchett of the Carnegie Foundation."

The Minimum Standard for Hospitals has five clauses having to do with (1) organization of the medical staff; (2) qualifications of medical staff members; (3) holding of medical staff conferences for the purpose of review and analysis of cases; (4) keeping of accurate and complete medical records; and (5) diagnostic and therapeutic facilities. Although only minor changes have been made in the wording since it was formulated in 1918, it remains completely modern because it is a statement of principles rather than of details of

application, and the interpretation has advanced with hospital progress. To the basic standard have been added sixteen Minimum Standards covering distinct departments or services in the hospital, namely, (1) clinical laboratories; (2) x-ray departments; (3) surgical departments; (4) departments of anesthesia; (5) obstetrical departments; (6) eye, ear, nose and throat departments; (7) treatment of fractures; (8) traumatic surgery; (9) cancer clinics; (10) physical therapy departments; (11) outpatient departments; (12) pharmacies; (13) nursing services; (14) dietary departments; (15) medical social service; and (16) medical library.

Approval Procedure. Each year every hospital under survey is reconsidered for approval in the light of the reports and other late information available. Representatives are constantly in the field surveying hospitals and gathering information about them. Announcement of the Approved List is made officially at the Hospital Standardization Conference held in connection with the Clinical Congress each year. The list is published in the Approval Number of the College Bulletin. Approved hospitals receive certificates for display.

Clearing House of Information on Hospitals. The College now has in its files more than 50,000 reports of Hospital Standardization surveys—an invaluable mine of reference material, tremendously illuminating in showing the steady advance of hospitals, singly and collectively—as the process of survey, reporting recommendations back to the hospital, follow-up and re-survey have persistently gone on year after year. The reports form the foundation of an accumulation of reference material on hospitals which is utilized by them and by various associations.

Hospital Standardization Conferences. Hospital Standardization Conferences are held each year in connection with the Clinical Congress. They consist of general sessions, panel discussions, round table conferences, consultations, demonstrations in the local hospitals and exhibits. The

conferences, attended chiefly by hospital administrators and heads of departments in the hospital, also attract medical staff members, some of whom are always included in the program to present papers dealing with various phases of hospital service and to take part in the panel discussions. Similar conferences are held in connection with Sectional Meetings.

Co-operation with and by Hospitals. Hospital Standardization has been a self-imposed task and it has been carried forward at great expenditure of time, energy and funds. All expense except an original grant of \$105,000 from the Carnegie Fund has been borne by the College. The hospitals in general have welcomed criticisms and suggestions, and a program that might have made enemies for the College has been one of its chief means of building good will since the work has been done in a spirit of service to the hospital, the surgeon and the patient. The benefits are of course directly shared by the internist and all other members of the professional and administrative staffs. Improved hospitals mean improved surgical results, but they also mean higher standards of care for all types of patients.

The co-operation of the hospitals in this voluntary movement is shown by the fact that in 1940 a total of 2,806 hospitals having twenty-five beds or more were approved, out of 3,677 under survey. Of hospitals having 100 beds or more, 1,853 out of 1,986, or 93.3 per cent, are approved.

WIDE RECOGNITION OF HOSPITAL STANDARDIZATION

It is noteworthy that the Hospital Standardization program was endorsed at the Third Pan-American Scientific Congress held in Lima, Peru, in December, 1924, and that upon request, surveys were made of about forty hospitals in South America and several were placed upon the Approved List. In 1926, Malcolm T. MacEachern, Associate Director in charge of hospital activities, was loaned by the College to Australia and New Zealand at the request of their governments and the British Medi-

cal Association of both countries, for the purpose of advising with them regarding future policies and development of their hospitals. While there, he laid the foundation for the remodeling of their institutions along the lines laid down by the Minimum Standard of the College.

In 1929, Hospital Standardization was the subject of special discussion at the Pan-Pacific Surgical Congress in Honolulu. It has been presented and discussed at several meetings of the International Hospital Association, of which Dr. MacEachern has been president since 1938. In 1940, it was among the subjects discussed at the First Inter-American Conference on Hospital Administration held in Puerto Rico.

It is neither possible nor desirable to avoid tracing the success of a program of this kind to the individuals who are responsible for its direction. The pioneer work has been mentioned. The Minimum Standard was drawn up by the Director of the College in 1918, John G. Bowman, now Chancellor of the University of Pittsburgh. Since 1921, the Department of Hospital Standardization has been headed by Dr. MacEachern, an experienced hospital administrator, who has won prestige and good will for his organization by his whole-souled devotion to the cause of better hospitals. Active also in the work of Hospital Standardization is Assistant Director Earl W. Williamson, who joined the organization in 1922.

CLINICAL RESEARCH

The idea of conducting clinical research originated in the Clinical Congress of Surgeons of North America before the College was organized. As has been mentioned, the Congress in 1912 appointed a committee to disseminate information about cancer to the public. In his report the following year the chairman, Dr. Cullen, after telling of the numerous articles that had appeared in leading magazines and newspapers and of their already noticeable effect in bringing patients to seek treatment earlier, said:

"Your committee finds that accurate data on cancer in the United States are very meager. If the people of the land are to be enlightened, we must keep better records. . . . With the increased number of cancer patients coming early for operation the percentage of cures will naturally be increased and with the improved methods of operating this percentage will be still further improved. It is this continued increase in the number of permanent cures that we must keep continually before the public."

That was the germ of the idea that ripened in 1930 into the archives for five-year cancer cures. More than 30,000 five-year cures are now recorded, constituting one of the strong arguments in the "Cancer is Curable Fight it with Knowledge" campaign in which the College and other organizations are co-operating with the American Society for the Control of Cancer. The work which led to the establishment of the archives was begun in 1922 by a committee under the chairmanship of Robert B. Greenough. Its first activity was to assemble from selected clinics as many accurate and complete records as possible of cancer of the cervix and of the breast. In July, 1924, Dr. Greenough reported on the three-year results of treatment of cancer of the cervix, and in August, 1929, on five-year results of cancer of the cervix and breast. These individual cases were reported on special record forms. Other forms have been added until there are now twenty-three for cancer of different parts of the body, widespread adoption of which is doing much to improve cancer records and to secure comparable statistical material from many sources.

In 1921, at the instigation of Ernest Amory Codman, the Registry of Bone Sarcoma was established. No better example of a concerted, co-operative study of one subject exists. More than 2,200 cases have been registered with complete histories. Annual follow-ups on these cases have been continuous and almost complete. Each case has been studied by a dozen or more members of the committee and others, and the independent opinions of each are

recorded. Annual reports have been issued and a considerable number of published studies on bone tumors have been based on the Registry material, which has also served in medical schools and other centers for demonstration purposes and personal and group studies. A uniform classification of bone tumors was adopted in 1923, revised in 1928 and again in 1939; it has been adopted by surgeons, pathologists and radiologists throughout America and other countries, introducing uniformity into a previously chaotic field. The work of the Registry has resulted in more accurate diagnoses and more effective treatment of bone tumors. The diagnosis of benign tumors, for instance, some of which were formerly considered malignant, has saved many limbs which might otherwise have been sacrificed, and new entities have been discovered and described and information about them disseminated.

An important result of the Bone Sarcoma Registry has been the example set in accurate and complete follow-up and recording of cases, which has been imitated in many registries of various kinds of surgical and medical cases now in existence.

As Dr. Martin said in connection with the starting of clinical research activities, great universities and philanthropic foundations and individuals of wealth have invested vast sums in support of scientific research, but clinical research has been neglected. The College entered a field which he called "unlimited in extent, unappropriated, and of inestimable value to the actual practice of medicine."

In charge of the Department of Clinical Research since 1926 has been a practical pathologist, Dr. Bowman C. Crowell, associate director of the College, who had won distinction in the teaching field before he joined the organization. In addition to clinical research, which is largely concerned with cancer, he has under his direction the activities in connection with the organization of cancer clinics, with standardization of medical service in industry, and with the

improvement of the treatment of fractures and other traumas.

CANCER CLINICS

In 1927, the American Society for the Control of Cancer appointed a committee consisting of Dr. Ewing, Dr. Greenough and Dr. Gerster, to report on the best method of improving service to the cancer patient. In 1929, that committee reported on the medical service available and made suggestions for its improvement, among which was a more widespread organization of cancer clinics in general hospitals. The offer of the American College of Surgeons to develop the cancer clinic idea was welcomed. The College, therefore, formulated in 1930 a Minimum Standard for cancer clinics in general hospitals and offered recommendations for their formation. The purpose of these clinics was to furnish the patient with all available diagnostic and therapeutic measures, to furnish authoritative data of a comparable nature from clinic to clinic and to act as a clearing house of information for a united fight against cancer.

Surveys of existing facilities were begun in 1931, and in 1932 the College announced the first list of 100 approved cancer clinics. On the October, 1940, approved list there were 345 clinics, constituting 23 per cent of the approved general hospitals having 100 or more beds. Through the approved clinics there passed in 1939 a total of 78,000 patients who benefited by the group consultation in diagnosis and treatment. The College believes that at least 40 per cent of hospitals having 100 or more beds should have organized cancer clinics in order to provide adequate service.

Through its work of encouraging the formation and establishment of standards for cancer clinics, the College has earned recognition as the national organization which is doing the most constructive work in the clinical control of cancer. The Advisory Cancer Council, through the National Cancer Institute, has extended

grants-in-aid for the past two years to help cover the expense of some of the surveys.

In every case in which a state has taken measures to control cancer, recognition has been given to the College standards, sometimes to the extent of requiring College approval of clinics before state aid will be granted. Advice from the College has been sought by all of the states in planning their work.

MEDICAL SERVICE IN INDUSTRY

Activities in the field of medical service in industry developed from the work in Hospital Standardization. The initial impetus came from the chairman of the Medical and Surgical Section of the American Railway Association in 1920, Dr. Daniel Z. Dunott of Baltimore. At his instigation the Railway Association adopted on November 16, 1921, a resolution providing that:

"Whenever possible only hospitals rated as Class 'A' by the American College of Surgeons be recognized, and when railroads have their own hospitals, such institutions not already so classified be brought to such standard."

Afterward Dr. Dunott asked:

"Why doesn't the College do for industrial surgery what it did for hospitals?"

The question was answered with investigations of medical services in the lumber mills of the West, in the oil fields of the South and in the industrial plants in New York City. Since the findings disclosed a great need for higher standards, a committee with Frederic A. Besley as chairman was appointed in 1926 to work toward better organization and service in caring for the ill and injured in industry, for the elimination or control of industrial health hazards and for the institution of other health preservation measures. A Minimum Standard for Medical Service in Industry, applicable to all industrial organizations regardless of size, was formulated following personal surveys by representatives of the College. The first list of approved medical services was

published in 1933. The 1940 list showed 937 medical services approved out of 1,787 under survey, or 52 per cent.

A manual entitled "Medical Service in Industry and Workmen's Compensation Laws" was prepared in 1934 by Dr. M. N. Newquist and revised in 1938, for the guidance of firms desiring to meet the requirements. Industry in general has welcomed the standard and the certificate of approval is displayed to show that confidence of the employees in the service is merited.

Medical service in industry, before this movement started, was a stepchild in the industrial plant, and was at the same time neglected and more or less disapproved of by its parent, medicine. Its prestige has grown as its potentialities have been recognized and the standards have been raised. Accompanying the improvement has been direct benefit to both employer and employee. Many valuable contributions are being made today by the medical departments of industrial concerns, and undoubtedly the work of the College in this field has been influential and stimulating.

FRACTURES AND OTHER TRAUMAS

A committee on fractures was appointed in 1922 with Charles L. Scudder as chairman. Its aims are best expressed in the chairman's first report:

"During the war period fractures were treated by both British and American surgeons with results hitherto deemed impossible, but there is no recognized authoritative standardization of fundamental principles governing the treatment of fractures. There are no generally recognized appropriate uniform methods of treatment."

The committee has conducted a continuous educational program among surgeons to provide better care for fractures. These efforts have done much to reduce the tremendous social and economic loss resulting from the million or more fractures which occur in the United States and Canada annually. One of the concrete aids

has been the publication of an "Outline of the Treatment of Fractures," first issued in 1931, and last revised and amplified in 1940. The "Outline" enjoys an established position as the most authoritative and most widely used guide in the treatment of fractures.

That the work of this committee, now known as the Committee on Fractures and Other Traumas, is widespread, is shown by the fact that subsidiary to it are eighty-five regional fracture committees having a membership of about 1,400 surgeons. These committees carry out the various programs evolved by the fracture committee, which include using influence locally for the provision of adequate, safe transportation from the site of injury to the place of treatment, the proper equipment of ambulances, provision in the hospitals of special accommodations for the reception of emergency cases, adequate organization for the proper care of patients with fracture in hospitals and education both for the profession in the care of fractures and for the laity in the application of first aid.

GRADUATE TRAINING IN GENERAL SURGERY AND THE SURGICAL SPECIALTIES

The educational function has been dominant in the efforts of the College to elevate the standards of surgery. It has been furthered through all of its activities, beginning with the establishment of qualifications for fellowship, which must be high, but must also be attainable so that they may be enforced. Helping the prospective Fellow to gain the requisite training has always been a concern of the College, and since 1930 several committees have been appointed to study the problem. In 1937, a Committee on Graduate Training in Surgery was established to investigate, analyze and evaluate the opportunities for the training of surgeons in hospitals of the United States and Canada.

The field staff began personal surveys of a selected group of hospitals in 1937, in connection with the work of the Depart-

ment of Hospital Standardization. As a result of these surveys, information was gathered for the development of fundamental principles upon which acceptable plans of training should be based. These were elaborated in 1940 into the "Manual of Graduate Training in Surgery," prepared by Assistant Director Harold Earnheart, which contains and explains the "Minimum Standard for Graduate Training in Surgery."

The fundamental principles were applied as a basis for approval in 1938 and 1939 and a list of hospitals of the United States and Canada approved for graduate training in surgery was published first in January, 1939. The Approval Number of the Bulletin of the College in October, 1940, contained a list of 200 hospitals which met the new Minimum Standard for graduate training in surgery, and also a directory of the approved plans, including detailed description of the provisions for basic science study, supervision and the gaining of practical experience.

The program of the College is in harmony with the recommendations of the Commission on Graduate Medical Education, on which the College was represented, whose report was published in June, 1940. This report says in part:

"A vigorous approval program for residencies acts as a strong stimulus to hospitals to organize their services so that they can meet the required standards. . . . Modern transportation and the better distribution of well qualified specialists should in the relatively near future make specialized medical services available in all but the smaller communities. . . . Many hospitals have recognized that, even from the purely selfish standpoint of improving their community standing through better medical service and thus helping to fill their empty beds, they can well afford to support an educational program for interns and residents. . . . During 1938 and 1939, the American College of Surgeons published a series of reviews of hospital residency programs in surgery and the surgical specialties that met the standards of the College. While these articles describe only the surgical services, they do indicate the wide

variety of good educational programs being developed by hospitals and medical schools in various parts of the country. Cost appears not to be an insurmountable obstacle to the development of good programs."

The directory that has now been published is the first presentation of selected graduate training programs that has ever been available to the graduate in medicine as a guide in his plans for qualifying himself to practice surgery. It makes possible careful selection of the institution which offers the program best suited to the individual's needs. Unquestionably, there is also a stimulation to the hospital in having its program appear in a form permitting ready comparison with the programs of other institutions.

The hospitals have co-operated enthusiastically in the program, and have acknowledged that the new "Manual" is of great aid to them. On specific problems, they consult the College, and are showing eagerness to have their graduate training programs, as one director expressed it, enable them to "take our part in providing the needed services for the training of surgeons who will be able to qualify as specialists in surgery." Many of them want to know how nonteaching hospitals can become teaching institutions, and they are told that this can be done through interest and effort of the medical staff and the existence of sufficient pathologic material and a pathologist willing to devote the time to teaching.

The College has encouraged more hospitals to assume the responsibility of training surgeons according to high standards, which include provision for basic science study on the gradual level as well as systematic supervision and other essential elements of a well rounded program requiring two and preferably three or more years of training in surgery following a year of general internship. The requirements for fellowship have recently been raised to include this amount of training.

The fullest co-operation has been extended by the College to the various

surgical specialty boards in their work of stimulating higher qualifications. All of the boards are made up of Fellows of the College. For the first board that was formed, the American Board of Ophthalmology incorporated in May, 1917, the College provided office space and secretarial aid for the first two years of its existence.

The aim of the College is to increase the opportunities for acceptable training in the moderately sized communities as well as the large medical centers, for more people live in such communities and well qualified surgeons should be better distributed than is the case today.

POSTGRADUATE EDUCATION OF THE SURGEON

The College utilizes every available means and is constantly devising new ones to further postgraduate education of the surgeon. Some of these means are, visual education through clinics and demonstrations, exhibits and medical motion pictures; verbal education through its publications and its library and department of literary research; and oral education through programs given by members of the fracture committees, for instance, at professional gatherings, and through the scientific sessions, conferences and panel discussions at the Clinical Congress and Sectional Meetings.

Clinical Congress and Sectional Meetings. A leading method of postgraduate education utilized by the College remains the surgical clinic—the “show me” idea. The 1940 Clinical Congress, with its five days of operative clinics, demonstrations, and exhibits in forty or more approved hospitals in Chicago, was the thirtieth. The clinical programs are so arranged that subjects in general surgery, orthopedic surgery, thoracic surgery, neurosurgery, cancer, fractures and other traumas, urology, obstetrics and gynecology, ophthalmology, and otorhinolaryngology are correlated to enable the surgeons to devote their time continuously to clinics dealing with the

specialty in which they are most interested. Clinics are also held in connection with the Sectional Meetings, conducted each year since 1923 in three or more medical centers not large enough to accommodate the Clinical Congress, but providing sufficient clinical facilities to attract surgeons in an area ranging from six to twelve states or provinces.

As the years have passed, however, the scientific sessions, conferences and symposia have been attracting so much interest that the program has had to be extended and developed. Perhaps two reasons account for this; first, the prospective surgeon today has a longer period of training than the one of twenty years ago and sees more operative work, therefore, he has not the avid eagerness of the generation that preceded him to see surgeons perform, because he has had more opportunity to satisfy his curiosity in this respect; second, the surgical motion picture and the improved technic in graphic presentation of cases and follow-up studies have made the large operative clinic less necessary, although still important. Increasing appreciation of the importance of rigid asepsis in the operating room has also been a factor discouraging the presence of observers except in very limited numbers.

The Clinical Congresses attract three thousand or more surgeons to the large medical center in which they are held, and the Sectional Meetings often attract a thousand or more registrants.

The symposia have an especially valuable means of furthering the special activities of the College. A series of “Cancer is Curable” symposia, for example, at successive Clinical Congresses, stimulated the establishment of the archives of five-year cures and of interest in the encouragement of cancer clinics. Improved treatment of fractures and other traumas has been furthered through the usual symposia on this subject, as well as the clinics devoted to it.

Library and Department of Literary Research. The Library was organized in

1921. It comprises a collection of some 25,000 volumes including current textbooks, journal files and historical works. These reference works are supplemented by a collection in excess of 100,000 reprints. Many rare books and manuscripts have been contributed.

The Department of Literary Research consists of a staff of workers equipped to select reprints on medical and surgical subjects, compile bibliographies, prepare abstracts and make translations. Reprints are supplied without charge in package library form. Each year, many requests for literary research are received, some of them being continuous surveys which have been carried forward through the years. The charge for the research service is nominal in comparison with the service that is rendered.

Medical Motion Pictures. The study of medical motion pictures for the profession and the laity was undertaken by the College in 1926 as the value of this medium of education became recognized. Specific fundamental requirements concerned with selection of the subject matter, preparation of the scenario, ethics, illustration by animation or drawings, photography and teaching value were developed by the College for use in evaluating films. Films received are reviewed by a committee of recognized authorities on the subject matter portrayed. The committee often suggests to authors ways in which films may be improved. When they are approved, the author of the film is authorized to insert a legend showing such approval. A list of approved films is published in the Year Book and in the Approval Number of the College Bulletin. The first film approved was one by Allen B. Kanavel on "Infections of the Hand" which is still authoritative and widely shown.

Medical motion picture showings are a feature of every Clinical Congress and Sectional Meeting of the College.

Exhibits. Under Dr. Crowell's direction, the College has acquired a number of educational and scientific exhibits,

assembled for the present on the ground floor of the John B. Murphy Memorial Building adjoining the College headquarters, as contributions for the future Hall of the Art and Science of Surgery. Included are the Lister exhibit presented to the College in 1927 by Sir Henry Wellcome; exhibits presented by the Cleveland Clinic on the energy system of animals; an exhibit on the treatment of burns presented by Dr. Roy D. McClure and Dr. Grover C. Penberthy of Detroit; and exhibits on cancer, fractures and traumatic surgery which have been prepared by the College. The collection is not a museum in the strict sense, but is rather a repository for instructional material of significant and current interest in the development of surgery.

Scientific and technical exhibits are a feature of every Clinical Congress. The American College of Surgeons encourages scientific exhibits but has not developed this particular phase of the meeting as have other organizations. The exhibits shown by the College have largely to do with the progress of its numerous activities and serve chiefly to acquaint the Fellows with them.

Publications. The Official Journal of the College is *Surgery, Gynecology and Obstetrics*, with the *International Abstract of Surgery*, published monthly, with an additional special issue on February 15 in which papers presented at the Clinical Congress are published. The pages of the Journal are open to all surgeons whether or not they are Fellows. A Year Book is issued every alternate year, which contains a complete list of the Fellows and a summary of the various activities; in the intervening years a supplement is published containing the names of new Fellows admitted to the College and the annual reports of the different departments and committees. A Bulletin is issued five times a year, for distribution to Fellows, hospitals, Junior Candidates and others interested; the October issue is the "Approval Number" in which appear lists of approved

hospitals, hospitals approved for graduate training in surgery, approved medical services in industry, cancer clinics and medical motion pictures. The Year Book also contains these lists.

Reprints and monographs are distributed on occasion. Outstanding among these are: the "Manual of Hospital Standardization," revised and amplified in 1940; the "Outline of the Treatment of Fractures," revised and amplified in 1930; the manual on "Medical Service in Industry and Workmen's Compensation Laws," revised in 1938; the manual on "Organization and Conduct of Cancer Clinics in General Hospitals," published in 1939; and the "Manual of Graduate Training in General Surgery and the Surgical Specialties," published in June, 1940.

PUBLIC EDUCATION

The task of educating the public to appreciate the advantages of the best possible surgical and hospital service was undertaken as a necessary accompaniment to an effort to elevate the standards of surgery. The several means employed have been: *Community Health Meetings*. A feature of every Sectional Meeting and of most of the Clinical Congresses is an evening meeting for the public at which leaders in the profession give addresses, often illustrated, on topics relating to health, scientific medicine and improved hospital service. *Motion Pictures*. The work of the College in approving medical motion picture films extends to those intended for the laity as well as those of a professional nature. *Radio*. Specially prepared talks on health and medical science are broadcast during every Clinical Congress and Sectional Meeting. *Press*. Co-operation with the press has been close. The practice at the Clinical Congress and Sectional Meetings is to appoint a committee of surgeons representing general surgery and each of the surgical specialties to form a board of consultants with whom the representatives of the press may confer concerning the highly involved scientific

material that is often presented. The College also works constantly with newspapers and magazines in presenting to the public surgical and hospital news of interest. *Exhibits*. The public has a chance to view the exhibits in the headquarters hotel at the time of the Clinical Congress. Exhibits are also displayed on special occasions, for instance, at A Century of Progress Exposition in Chicago. On display at the present time in the Museum of Science and Industry in Chicago is an exhibit which portrays some phases of the history of surgery, the history of the development of the care of the sick and injured, the organization of medical services in industry and the essential features of Hospital Standardization.

ADMINISTRATION

The College was founded largely on the administrative genius of one man, but Dr. Martin built well and selected his associates wisely and the steady progress of constructive activity was not interrupted by his passing in 1935. Associate Directors, Crowell and MacEachern, already had the confidence of the fellowship, and the years since have established them firmly as leaders who have the judgment and vision needed to carry the College forward.

The administrative staff, exclusive of the Journal, consists of about fifty-five members, housed in the attractive headquarters building presented in 1919 by lay friends and Fellows residing in Chicago. Adjoining is the Murphy Memorial Building, a gift by the family and friends of Dr. Murphy, which houses assembly halls, the library and temporary museum space. The entire College property, which includes the quarter block diagonally opposite the headquarters' building on Erie Street, is conservatively estimated at one and one-quarter million dollars.

The expense of the activities is around a quarter of a million dollars a year, including the salaries of the administrative staff. The work is supported chiefly by the fellowship through contributions to the

endowment fund and the payment of a fellowship fee and annual dues.

OFFICIAL LEADERSHIP

George Crile of Cleveland was chairman of the Board of Regents from 1924 to 1939; the present chairman is Irvin Abell of Louisville. The president for 1940-1941 is Evarts A. Graham of St. Louis. His predecessors have been:

John M. T. Finney, Baltimore	1913-1916
George Crile, Cleveland	1916-1917
William J. Mayo, Rochester	1918-1920
George E. Armstrong, Montreal	1920-1921
John B. Deaver, Philadelphia	1921-1922
Harvey Cushing, Boston	1922-1923
Albert J. Ochsner, Chicago	1923-1924
Charles H. Mayo, Rochester	1924-1925
Rudolph Matas, New Orleans	1925-1926
W. W. Chipman, Montreal	1926-1927
George D. Stewart, New York	1927-1928
Franklin H. Martin, Chicago	1928-1929
Merritte W. Ireland, Washington	1929-1930
C. Jeff Miller, New Orleans	1930-1931
Allen B. Kanavel, Chicago	1931-1932
J. Bentley Squier, New York	1932-1933
William D. Haggard, Nashville	1933-1934
Robert B. Greenough, Boston	1934-1935
Donald C. Balfour, Rochester	1935-1936
Eugene H. Pool, New York	1936-1937
Frederic A. Besley, Waukegan	1937-1938
Howard C. Naffziger, San Francisco	1938-1939
George P. Muller, Philadelphia	1939-1940

SUMMARY

The progress of surgery in America and the progress of the American College of Surgeons are synonymous because the College has set itself to discover needs and to shape its activities toward meeting them. It is not a membership organization whose primary object it is to protect and to promote the interests of its members individually. The purpose is rather to provide an avenue through which the members may submerge their individual and selfish interests and unitedly focus effort on improving their service to the patient. The active interest of the organization in the education and training of the surgeon and in improvement of the envi-

ronment in which he works in hospitals and in industry, is centered not upon him personally but upon enabling him to obtain better surgical results. This larger concept completely coincides with the highest motive of the individual surgeon who has dedicated himself to service.

The formula that the College follows is almost always the same, whether great projects like the standardization of hospitals and the organization of cancer clinics, or lesser ones like the standardization of surgical dressings and the approval of surgical equipment, are involved. First comes recognition of the problem. Second comes survey to determine the actual conditions and the extent of the need. Third, the co-operation of other groups concerned is sought, and effort is made to avoid duplication of effort. Fourth, a permanent set-up is established, either as a function of an administrative department or of a committee or committees under administrative guidance. Fifth, a standard is formulated, the meeting of which will help to correct the fault or overcome the deficiency. Sixth, the need and the way in which it can be met are publicized. Seventh, surveys are made to determine who are meeting the standard, and the approval list is publicized as a spur to competition. Eighth, assistance is given in meeting the requirements. Ninth, constant resurveys are made to assure maintenance of the standard. Tenth, progressive interpretation of the standard is made to conform with scientific, technical and ideologic advancement.

Participation in the activities is possible for an exceedingly large proportion of the fellowship at any given time. There are executive, credentials and judiciary committees in every state and province, and in ninety-one different districts there are in addition committees on applicants. On the eighty-five regional fracture committees are 1,400 men. On the Board of Governors are 150 members. More than 200 Fellows are serving on the other committees, including the Committee on the Library, the Committee on Fractures and Other Trau-

mas, the Committee on the Hall of the Art and Science of Surgery, the Committee on Bone Sarcoma, the Committee on Medical Motion Pictures, the Joint Committee on Nursing Service with American Nurses Association, the Committee on Graduate Training, the Advisory Council for Ophthalmology, the Advisory Council for Otolaryngology, the Board of Regents, Executive Committee, Finance Committee and Advisory Council to the Board of Regents. Participation in the meetings is another activity that is well supported by the entire fellowship. The roster of names of speakers, leaders of discussions, and clinical demonstrators at the Clinical Congress and Sectional Meetings through the years constitutes a roll call of the outstanding American and many foreign surgeons, and the published papers furnish year by year records of progress in surgery in general and in special fields.

Looking ahead, the College faces with the rest of the nation, as it did once before, the threat of war. With the same enthusiastic response, it is rising to the needs of the national defense program. The chairman of the Board of Regents, Dr. Abell, is chairman of the committee appointed in September, 1940, to co-operate with the national defense commission of the United States on all phases of public health. Serving with him are the three Surgeons General, all Fellows of the College. The 1940-1941 president, Dr. Graham, is chairman, and Regent Alton Ochsner of New Orleans is vice chairman of the Advisory Committee on Surgery of the National Research Council, appointed in June, 1940.

This committee has several subcommittees to represent the various surgical specialties and to investigate specific problems. Most of the members of the committees are Fellows of the College, so that again the organization that represents the surgical profession in action and as a whole, is in a national emergency enabling the surgeon to present a united front.

There are those now who criticize the American College of Surgeons because of its size, its inclusiveness, as once there were those who feared it would be an "oriental oligarchy," patterned after the "aristocracy of the old world." It is true that the College fellowship roll of nearly 13,000 makes it the largest surgical organization in the world. However, the aim has never been to create an exclusive organization for the purpose of giving distinction to the members, but to set the qualifications just high enough so that they can be attained with reasonable effort under existing circumstances by the competent surgeons upon whom the public throughout the country must rely and for whose competency an authoritative gauge is needed as a basis for public confidence. The aim "to elevate the standards of surgery" is interpreted as an obligation to elevate the standards of the greatest possible number of surgeons.

Succinctly, Donald C. Balfour, in his presidential address in 1935, stated the significance of the American College of Surgeons to progress of surgery in America:

"The accomplishments of the American College of Surgeons are recorded in the status attained by American surgery today."



CERTIFICATION OF SPECIALISTS BY THE AMERICAN BOARDS

PAUL TITUS, M.D.

Secretary of the American Board of Obstetrics and Gynecology and of the Advisory Board for Medical Specialties
PITTSBURGH, PENNSYLVANIA

THE organization of the American Boards for examination and certification of specialists by official groups representing thirteen separate medical specialties is essentially an educational movement. It marks a second important phase in the move to improve medical education in this country, this being related directly to graduate, as distinguished from undergraduate, medical education.

The first phase dealt with undergraduate medical education, which up to about 1900 was in a deplorable state due to the existence of "diploma mills," "night schools" of medicine, as well as poorly equipped medical schools in recognized universities, functioning and turning out doctors of medicine in direct competition and holding equal rights with graduates of the finer, properly conducted medical schools. The state licensing boards constituted the only deterrent to these poorly taught recent graduates, and on that account many such schools specialized in "quiz courses" designed for the express purpose of coaching their graduates to pass state board examinations. The universities themselves, the licensing boards, various interested philanthropic foundations, and the Council on Medical Education and Hospitals of the American Medical Association recognized the need for radical improvements and higher minimum standards of undergraduate medical education. Through their combined efforts, the extensive surveys of medical schools with their classification and formal recognition or loss of recognition by the American Medical Association and by State boards initiated at about that time (1900) that first phase which has resulted in the extraordinary elevation of under-

graduate medical education in this country with which now we are all familiar.

How immensely this has been of benefit to the sick public of this country cannot possibly be estimated.

During all of this time there were specialists in various fields of medicine. Some of them were well qualified for their special practice and many were not. Training and experience in the specialties were acquired in various ways. The usual method was that of prolonged assistantships under the tutelage of some already recognized specialist, working up through dispensary services and assistant staff hospital ward appointments to direct associateships, with gradually increasing responsibilities, opportunities and clinical privileges. Internships and residencies in the various specialties were relatively uncommon, and the opportunities for what we speak of now as intensive training by the special residency system were distinctly limited in number throughout the country. Short "refresher" courses or visits to clinics in the larger centers here or abroad were considered admirable in rounding out a man's special training by the assistantship method. Longer courses and even hospital services were obtainable, chiefly on the European continent, and several postgraduate schools were established in this country in an effort partially to supply the demand for graduate medical education, but the entire situation was chaotic and entirely unregulated.

There was nothing by way of standards or formal appraisal of qualifications to gauge or establish a man's right to call himself a specialist in any branch of medicine, and even to this moment the American Medical Directory feels obliged to accept a

man's own appraisal of himself in its inclusion of symbols indicating specialization after the names in its Directory lists.

Both the lay and the medical public had little else by which to judge capability than an individual's self-appraisal and his own announcement of himself as a specialist. It is true that results counted for much and the well trained man was outstanding in his specialty, but the public is gullible and incapable of judging about such things. There was nothing to assure the public that the fundamental requirement for a claim to "specialization," namely, adequate preliminary training and unusual opportunity for clinical experience, had been fulfilled. "Fee-splitting" flourished, practices grew and some of the less qualified specialists became really competent from what they learned while practicing on the private patients who had come to them in all good faith.

As said before, however, there were many really well trained men in the specialties and others following them who sought to be as well or even better trained. Some with incomplete fundamental training were honest enough to recognize their own disadvantages and to wish to improve conditions and training facilities for their followers. The outstanding teachers and the heads of the better clinics realized the need for special internships and residencies for graduate medical education, and the establishment of such positions began to increase in number. Johns Hopkins, Harvard, Columbia, Yale, the Mayo Clinic and many, many others were setting inspiring examples in this, and more and more of the men who were their output began to fill the important posts in this country.

The first phase in our medical history which marked the phenomenal improvement in undergraduate medical education was leading naturally and logically to the second phase, or that related to graduate medical education. This latter demanded an improvement in graduate medical education, especially for the practice of the specialties, and some method whereby the

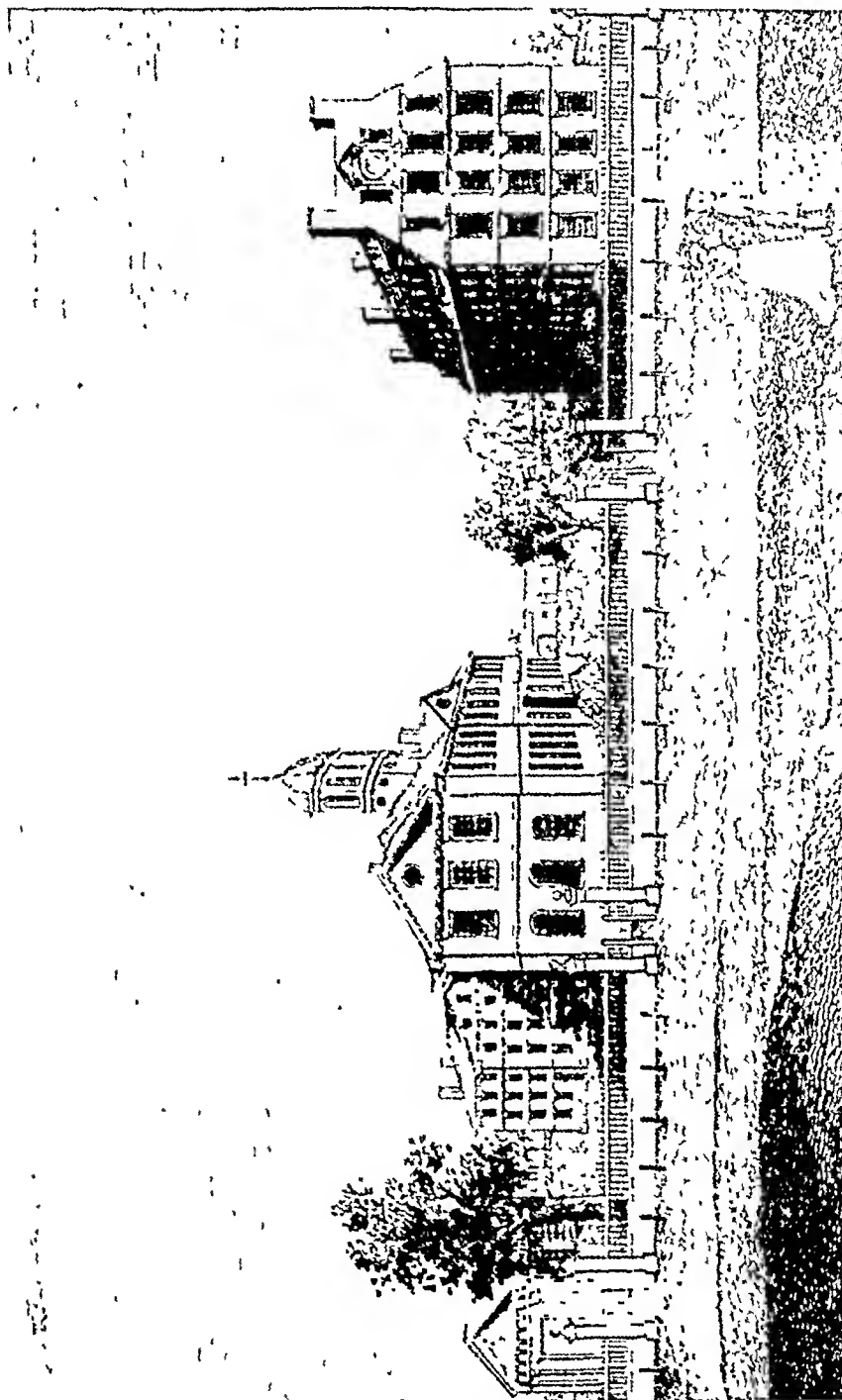
public and the profession might be able to evaluate the qualifications of those claiming to be specialists.

In 1916, the establishment of the American Board of Ophthalmology marked the first formal step in this and was the example which inspired all of the others that were to follow. This Board, composed of outstanding and recognized ophthalmologists, undertook to formulate certain minimum training requirements and then to examine and certify as specialists in ophthalmology those who applied voluntarily to the Board for such recognition. The American Board of Otolaryngology was created along similar lines with identical objectives in 1924, was followed in 1930 by the American Board of Obstetrics and Gynecology, and in 1932 by the American Board of Dermatology and Syphilology.

Graduate medical education and training in these specialties were given a sharp stimulus by the formation and activities of these Boards, because their requirements for admission to examination were and are rigid, and their examinations severe. Certification by them was eagerly sought, and it is a tribute to the medical profession that many men so thoroughly established in their specialties that they needed no Board certification applied solely to support the movement and to set an example to their younger associates and assistants.

Men who did not have sufficient special training to meet the requirements began to demand facilities for obtaining such training; others admitted to the examinations but meeting with failure sought almost invariably by diligent effort and further study to fit themselves to pass later re-examination. Thus, it will be seen that the movement was proving to be definitely an educational one.

By 1933, these four existing Boards as well as the leaders of interested groups, such as the Association of American Medical Colleges, the American Hospital Association, the Federation of State Medical Boards of the U. S. A., and the National Board of Medical Examiners, had become



HARVARD MEDICAL SCHOOL

View of the Colleges at Cambridge, Massachusetts

concerned over the threat that various informal groups without authoritative sponsorship were about to organize similar examining and certifying Boards in specialties or subspecialties which might soon nullify the effect and force of the movement because of the very fact that they lacked the proper backing or sponsorship from strong national organizations. The four original Boards, in each instance, were composed of men officially appointed by the recognized national societies in the given specialty and the related special Section of the American Medical Association.

It was clear that rules must be formulated and steps taken to establish the official and formal nature of any and all Boards subsequently to be organized. Consequently, a meeting of representatives from the four Boards and the other above named organizations was called, and from this, in 1933, a liaison organization was formed termed the Advisory Board for Medical Specialties. The major specialties were defined and named, rules and regulations for the official formation of new Boards were adopted, and election of new Boards to membership in the Advisory Board was based upon adherence to the high standards established by the first four certifying Boards. Simultaneously, the House of Delegates of the American Medical Association, through the good offices of its Council on Medical Education and Hospitals, adopted an identical set of regulations, and the Council agreed not to recognize any group as an American Board which had not been previously approved and recommended by the Advisory Board.

Since then, the American Boards of Pediatrics, Psychiatry and Neurology, Radiology, Orthopaedic Surgery, Urology, Internal Medicine, Pathology, Surgery, Neurological Surgery, with two subsidiary or affiliate (with Surgery) Boards of Anesthesiology, and Plastic Surgery, have been officially organized and have begun to function.

It is interesting to note that the educational aspect of this movement is emphasized by the fact that the two presidents of

the Advisory Board, whose tenure of office covers the period from its inception to the present moment, were chosen in both instances from the representatives of the Association of American Medical Colleges serving on the Board. They were Dr. Louis B. Wilson, and subsequently, Dr. Willard C. Rappleye, the present president.

The Advisory Board for Medical Specialties, meeting annually, has come to be a forum for the exchange of ideas and views between the representatives of the several Boards and the other educational groups making up its membership. Each certifying Board is entirely autonomous, but these joint meetings of their representatives have resulted in greater unification of standards and methods of qualification and examination of candidates. This year an annual round table conference is to be initiated for general discussion of items of mutual interest, such as the effect of terms of military service on eligibility requirements, refugees and their citizenship requirements, the value of written examinations, rulings regarding ethics and similar topics.

Early in 1940, the Advisory Board published the Directory of Medical Specialists certified by the American Boards. This volume was printed and issued through the Columbia University Press of New York and nearly 6,000 copies were distributed by subscription in its first year. Libraries, hospitals, social agencies, Government agencies and bureaus, insurance companies, industrial firms, foundations and many individuals subscribed for it. This Directory contains complete information about the organization of each Board and its examination requirements, a geographic listing with biographic data including much detailed information about each Diplomate of each Board, together with a complete alphabetic list with addresses of approximately 14,000 specialists certified to January 1, 1940. Since then, or during 1940, 1,500 more have been certified, which is about the average per year, and it is planned to publish new editions of the Directory every two years.

It is of current interest that every Corps Commander of the Medical Division of the United States Army has been supplied by the War Department with one or more copies of this Directory for active use in connection with the mobilization plan initiated by the recent passage of the Selective Service Act.

To emphasize still further the contention that certification of specialists is fundamentally an educational movement, and that it has resulted in a pronounced improvement in qualification for special practice, one needs only to note its effects on young men seeking special training and on the institutions which provide the clinical facilities for such graduate medical education. More and more demands are being made by young graduates serving their interne years for places where internships and residencies in the specialties may be had. More and more institutions throughout the country are revamping their services to supply these demands. Both the men and the institutions profit by this, but most of all it is the sick public which is benefited because of a definite bettering of the standards of practice throughout the nation.

The concrete results of this demand and the effort to supply it are shown by the facts that in 1930, 278 hospitals provided a total of 1,776 residencies and fellowships in the specialties approved by the Council on Medical Education and Hospitals of the American Medical Association. At present or just ten years later there are 4,392 residencies and 726 fellowships, or a total of 5,118, in 587 hospitals of this country, according to the recent report of the Commission on Graduate Medical Education.

Surveys of the residency facilities of the country followed by approval of institutions for residency training in the specialties are no longer being carried out through the Council on Medical Education and Hospitals of the American Medical Association alone. At present, and as indicated by the latest Educational issue of *The Journal of the American Medical Association*, August 31, 1940, these surveys are being conducted by active cooperation be-

tween the Council and various special Boards, and approval is based on standards of graduate medical education designed to meet the requirements of the Boards for admission to their examinations. These requirements have been established by the Boards and amplified in their working details by the Commission on Graduate Medical Education of the Advisory Board.

The work of this Commission on Graduate Medical Education was sponsored, as stated above, by the Advisory Board for Medical Specialties. The Commission, under the direction of Dr. Robin C. Buerki, recently completed an extensive review of graduate medical educational facilities in this country, a report of which has been issued, and the Commission has now been dissolved. Its report is being actively studied, and its suggestions broadly adopted by many institutions engaged in this important work. It serves as an outstanding guide to institutions either establishing residency services in the specialties, or to those reorganizing these services to meet special training requirements.

Young men completing their general internships now seek rather than object to protracted periods of hospital training in the specialties amounting to several years, realizing that this is an investment well made. They not only know that they cannot qualify for Board certification as specialists without this but also have come to appreciate the value to themselves of this graduate medical training.

Certification of specialists and the effect that this has had upon graduate education in the medical specialties is rightly to be regarded, I believe, as an important phase in the medical history of this country.

The influence that such improved standards of training is already having upon the standards of the practice of medicine in this country must be obvious to every thinking person. Best of all, this movement for the general betterment of the care of the sick, like that of the improvement in undergraduate medical education, has been initiated and is being carried on entirely by the medical profession itself.

SOUTHERN SURGICAL ASSOCIATION

HISTORICAL SKETCH

HUBERT A. ROYSTER, M.D., SC.D. (HON.)

RALEIGH, NORTH CAROLINA

THE organization now known as the Southern Surgical Association had its beginning as the Alabama Surgical and Gynecological Association, launched in November, 1886, by Dr. W. E. B. Davis, of Birmingham, Alabama. At the initial conference in Birmingham on December 15, 1886, Dr. H. N. Rosser, also of Birmingham, was elected president and Dr. Davis, secretary. This Association was short-lived. It had but one regular meeting, at Birmingham, October 11 and 12, 1887. Even before that meeting plans had been laid for extending the organization and letters were sent to representative men throughout the South, inviting them to "attend the approaching meeting of the Alabama Surgical and Gynecological Association . . . with a view of forming the Southern Surgical and Gynecological Association."

The man most influential in Alabama medical circles at the time was Dr. Jerome Cochran. He opposed the organization as a State affair, on the ground that it would interfere with and disrupt the Alabama Medical Association. This discouraged Dr. Davis, who was the active spirit in the whole movement; but Cochran finally favored the enlargement of the original organization and Davis gave him credit for this accomplishment. Other able men throughout the South, eighty in number, joined enthusiastically in forming "a truly representative Southern special society." As to the title of the new organization, the famous David W. Yandell, of Louisville, "thought the union (Surgical and Gynecological) would prove rather an unsatisfactory one, as the general surgeon would not enjoy listening to a gynecologist discuss dysmenorrhea and

the gynecologist would have very little interest in the treatment of a fracture of the thigh." Upon this Davis commented: "With so great a surgeon speaking disparagingly of it—and this was the first association where the surgeons and gynecologists were combined in this way—its name has anticipated what may be expected in the future. Indeed, purely gynecological Societies will prove less frequent with each recurring year." In one respect, at least, this utterance was tardily prophetic, for twenty-eight years later the name of the Association was changed by omission of "and Gynecological," although papers on that surgical specialty continued to appear and still appear on its programs, and gynecologists form a notable, if not a large, group of its membership. And who can say "nay" to the gynecologist within our ranks when the official seal of the Association, adopted at its second session, bears the vignette of the famous Kentuckian, Ephraim McDowell, the world's first ovariectomist?

On the second day of the first and only meeting of the Alabama Association, October 12, 1887, organization of the Southern Association was perfected, with Dr. W. D. Haggard, Sr., of Nashville, as president, Dr. Davis, as secretary, and Dr. J. S. Cain, of Nashville, as chairman of the Judicial Council. "The ablest men in the South, although some were absent, were elected to fill the other places on the Council and were wired for their acceptances and they promptly responded in the affirmative."

A call for the next meeting was issued and this also was held in Birmingham on December 4, 5 and 6, 1888. All those, who had been accepted and paid their dues

during the time intervening since the first meeting, were placed on the roll as Founders. There were forty-one members in attendance and more than fifty visitors; ninety members already had been enrolled. Thirty papers were read either in person or by title. The Southern Surgical and Gynecological Association was on its way.

From its inception the Association fixed itself upon broad foundations. In his presidential address at Birmingham, December 4, 1888, Dr. W. D. Haggard, Sr., set the pace when he said: "The Southern Surgical and Gynecological Association did not spring voluntarily into existence, but was the outgrowth of necessity, and is the embodiment of power. It was the work of a few energetic minds and hearts that saw its needs, and seized the opportunity to give it form and being, which was accomplished in this city . . . in September 1887, at a most auspicious moment, and under most favorable circumstances." Clearly Dr. Haggard was interpreting the future policy of the Association, as he spoke further: "So we reach out our hands and invite into our circle such men as have by their works entitled them to the distinction of being educated, talented and industrious workers in the field of scientific research." That is a high mark for any surgical organization to adopt, but it is nothing short of what the Association has endeavored to reach during the fifty-three years of its continuous existence.

In using the expression, "we reach out our hands," the elder Haggard probably had in mind the further extension of Fellowship outside the territory. Established first as a state and then as a regional organization, the Association was never intended by the Founders to remain narrowly sectional in character. They foresaw the advantage of inviting surgeons from other parts of the country to unite with surgeons in the South for the interchange of ideas and experiences, so that those of the North, East and West might become better acquainted with their Southern confreres and present the fruits of their extensive

knowledge as authors and teachers; while the surgeons of the South in turn would be stimulated to record and publish their own



FIG. 1. William David Haggard, Sr., 1826-1901.
First president of the Southern Surgical Association.

work, and show to the world their just pride in the achievements of their predecessors, such as McDowell, Sims, Battey, Nott, Dugas, Stone, Briggs, Smythe, Dudley, Evc and others, as well as those of several illustrious surgeons then living and active. Among these were Haggard, Sr., McGuire, Kollock, Brown, Gaston, Yandell, Mastin, Campbell, Westmoreland, Kinloch and Miles. The first five became presidents of the Association; the others were at or beyond the retiring age. It is notable that the celebrated Robert Battey, of Rome, Georgia, one of the country's great gynecologists, then at the zenith of his power, failed to join the Association, explaining, according to Davis, that the withholding of his name was due to the fact that "The American Gynecological Society, [of which he was a Fellow and an ex-president] looked with suspicion upon anything gynecological that was organized

at that time" and that the members of that Society "had felt the necessity of fostering their strength."

In regard to the nonsectional character of the Association and its plan of expanding the membership, Davis from the beginning insisted "that there were not enough surgeons residing in the South, of reputation and ambition to attend such meetings, who could be gotten in sufficient numbers for a successful session, except in two or three cities of the South," and he "urged the Council to invite men of great eminence from the entire country to join the Association." He further "argued that they would constitute an inspiration for the Southern men and assist in making our meetings more successful." In his presidential address (1902) he reported: "Good men in the South who had not been known before and whose reputations would not have admitted them to the national special societies, met these men from other sections of the country, and, as a result, the majority of the deserving men of the South are now members of some of the national special Societies." This statement stands true today, thirty-eight years afterward, even in greater proportion than Davis could realize.

From its birth the Association embraced the original Southern States with the inclusion of Kentucky, Maryland, the District of Columbia and Missouri. Traditionally, no Fellows without the eleven strictly Southern States and the additional ones above mentioned, has held office or participated in the management of the Association's affairs. All Fellows, wherever their residence, have complete privileges to appear on the programs for the reading of papers, to engage in discussions and to join in the social diversions. The Association has held no meeting beyond its normal territory, except in two instances and both of these were in Cincinnati, Ohio. When Dr. Davis was elected president at Richmond, Virginia, in 1901, after a long term of service as the first secretary, it was by his request that the next session be held at

Cincinnati, where he had numbers of professional friends who had joined the Association in its earliest years and had given him personal support when he needed it. It was there also that he had been elected president of the American Association of Obstetricians and Gynecologists in 1900. Again, in 1915, Cincinnati was selected as the meeting place in deference to a unanimous invitation of the older Fellows then residing in that almost Southern latitude. It is significant that in his address at the 1902 session Davis said: "We want the Association to continue to hold its meetings in the South and in Cincinnati, and we desire all the great surgeons and gynecologists of this country to join with us in the meetings." On November 15, 1903, just a month before the next meeting at White Sulphur Springs, West Virginia, Dr. Davis passed to his reward. All the last twenty-five sessions since 1915, except five, have been held at winter resort hotels. Meetings took place in Baltimore, Memphis, Louisville, Atlanta, and Lexington, Kentucky, at the urgent requests of long time Fellows who wished to renew old memories.

On its fiftieth anniversary the Association convened, December 5, 1937, in Birmingham, Alabama, the place of its origin, and during the session a wreath of flowers was placed upon the monument to Dr. Davis which adorns a public park in the city. The custom still prevails of holding the annual meetings at well known winter resorts during the off-season when the Association usually has the hotels all to itself and its guests.

The first names placed on the rolls from regions outside the South were those of W. W. Potter, of Buffalo, Abraham M. Owen, of Evansville, Indiana, William M. Polk, of New York City, and Joseph Price, of Philadelphia, all of whom were elected in 1889. The last two were Southern-born and had risen to eminence as gynecologists in their respective localities. The next year the following extraterritorial surgeons were added to the Fellowship:

Johnstone, Reamy, Reed and Edwin Ricketts of Cincinnati, and Lydston, of Chicago. From that time on leading surgeons

part these members from the North, East and West attended regularly and manifested keen interest in the meetings up to

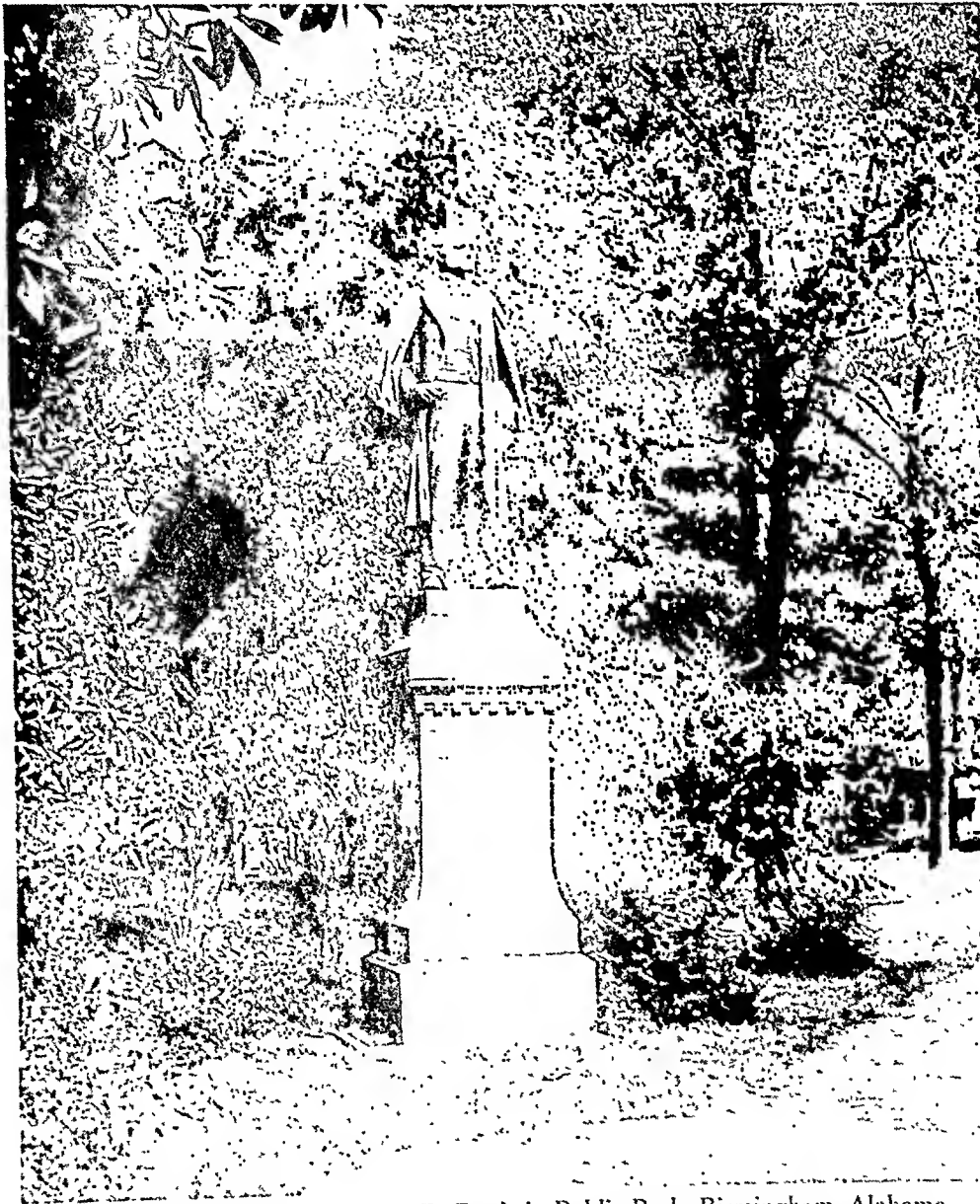


FIG. 2. Monument to Dr. W. E. B. Davis in Public Park, Birmingham, Alabama.

and gynecologists from various parts of the country were gradually elected. They were always chosen with care and due heed was given to the standing of the men. Those with Southern connections and sympathy were preferred but with no partisan prejudice, and the ratio of the membership was kept predominantly Southern.

Thus was carried out the intention of the Founders in building up and educating the younger surgeons of the South by their association with the ablest surgical teachers and clinicians in the land. For the most

the time of their retirement or death. Their places were filled, and are being filled today, in the same proportion with men of distinction. During the late nineties and at the beginning of the new century, when the Association had come into its own and was recognized in this country and abroad, many of the recently acquired Fellows from without the South were presenting papers and entering into the discussions with marked activity and appetite. Such notables as Wyeth, Senn, Murphy, A. J. Ochsner, Maurice Richardson, Mixer,

R. T. Morris, Baldy, Goffe, C. H. Mayo, Deaver, Coley, Crile and many others were giving their best work of each year



FIG. 3. William Elias Brownlee Davis, 1863–1903. Original founder, first secretary and fifteenth president of the Southern Surgical Association.

to the Association. The contributions of these men, combined with those of the distinguished surgeons in the normal Southern area, many of them teachers at the established medical schools in Baltimore, Richmond, Nashville, Atlanta, Louisville and New Orleans, furnished strong and varied programs for the annual meetings, and the Transactions of the Association soon began to present a fair cross-section of American surgery in its successive periods. As far back as 1899 Dr. A. M. Cartledge, of Louisville, in accepting the presidency, said: "Whenever I am away from home and the question of medical societies of America comes up, I hear men in the East frequently say that the best medical society in this country is the Southern Surgical and Gynecological Association . . . and we should feel a thrill of pride when some

four years ago the *British Medical Journal* . . . in commenting upon our annual volume of Transactions, just published, said that they are the best we have seen emanate from America."

Dr. Davis, when he retired as secretary in 1900, spoke in similar terms: "Our Transactions are not only quoted in this country, but abroad. It has in its membership men whose writings are prized wherever medical literature is known. This means much for a section, whose medical literature amounted to almost nothing fourteen years ago." This excellent reputation of the volumes is still retained and is due, no doubt, to the composite type of its papers and the informal character of the discussions.

In the preliminary organization "no mention of limitation of membership occurred in the letters which were sent out inviting the members of the profession to join the Association." The original intention was to restrict the number to one hundred, but, to overcome any possible prejudice, the roster was left open with the hope of selecting only desirable men. In the words of Davis, "it all depended upon how much value was placed upon membership." It was not until 1891, the fourth annual session, that any limit was placed and by that time the Association had grown to such an extent that of necessity the bounds were set at one hundred fifty. When that meeting adjourned there were one hundred twenty-three members on the roll and forty-eight had been in attendance. In 1902, eleven years later, the limit of Fellowship was advanced to two hundred, and there it has remained ever since. During the session of 1888 the membership totalled ninety-seven and thirty attended. At the fifty-first meeting in December, 1938, there were on the roll two hundred Fellows, fifty-eight Senior Fellows and five Honorary Fellows. Of these there were present one hundred fifty-six Fellows, forty-five ladies and professional guests, making a total of 301, a high-water mark.

Although the number of Senior Fellows is increasing each year, the roster remains filled, because of the ever growing applications for Fellowship. During the past year there were seventy-six applicants on the list, with only nine vacancies—five by death and four by transfer to the Senior Fellowship roll. Thus is verified the ideal set by Dr. Davis when he spoke of "how much value was placed upon membership."

The Southern Surgical Association prides itself on having each year a larger attendance of the wives of its Fellows and of its visitors and on being the first Association of its kind to invite the ladies to the annual dinner. It is a hard-working body and never at any time have the social activities interfered with its professional program.

Concerning the annual program, the by-laws provided in 1888 that "the president shall appoint fifteen members, each of whom shall prepare and read an essay or lecture upon some subject of his own selection . . . made known to the Secretary, and by him to each member . . . within the first three months after the adjournment." This rule was abrogated in 1890 and thereafter the preparation of the programs was left entirely in the hands of the secretary, who notifies the Fellows well in advance of the session, asking for voluntary papers or requesting contributions on special subjects. The secretary has authority to arrange the order of papers on the program according to their titles. Since 1918 it has been necessary to confine the number of papers to a maximum of forty. This limit is always exceeded long before each meeting.

Only minor changes in the constitution and by-laws had been made up to 1917. In that year sweeping revisions were adopted. The name was shortened to Southern Surgical Association and the title of member and membership changed to Fellow and Fellowship, respectively; qualifications for Fellowship were stepped up, requiring ten years' experience in surgery or one of its specialties; and all of its

surviving Founders, five in number, were added to the roster of Honorary Fellows. It was not until 1921 that a Senior Fellowship list was formed. Today this list contains sixty names, while there are only six Honorary Fellows, although as many as twenty-five are allowed.

Throughout its whole career, from the preliminary conferences up to this date, a period of nearly fifty-four years, the Association has had but five secretaries. The order of their continuity is as follows: W. Elias B. Davis, William D. Haggard, Hubert A. Royster, Robert L. Payne and Alton Ochsner. The first named served thirteen years; the second, sixteen years, the next two, nine years each, and the last named is the present incumbent, now in his sixth year of service. The secretary's term of office is five years, but all of them, Davis excepted, were elected to fill out unexpired terms and were reelected at least twice. All the former secretaries were elevated to the presidency while they were still filling their positions.

The importance of the secretary's office has been stressed throughout the history of the Association. Article VI of the constitution, as originally adopted and still in force, besides prescribing the normal duties of keeping the minutes, preserving records and registering members, charged the secretary with collecting dues, conducting correspondence and editing the Transactions. Some of these multifarious functions are performed by more than one official in similar organizations. The Southern Surgical Association gives over to its secretary the direction of its affairs, as specified above, and expects him to manage them, with the advice and consent of the Council, composed of the retiring presidents. Dr. Davis, the first secretary, regarded his post seriously, and labored untiringly and effectively until, after fifteen years he saw the Association firmly planted on solid ground, before he would agree to be released from the office and become president, a position with more honor and less work. By training the prospective secre-

taries in the traditions, the Association has continued the succession and the precedent has been warranted by the record. In the course of two more sessions, when the Association will be fifty-five years old, its five secretaries will have served an average time of eleven years each. The States represented in sequence by the secretaries are: Alabama, Tennessee, North Carolina, Virginia and Louisiana.

The fifty-three presidents of the Association in the order of their election are recorded as follows: W. D. Haggard, Hunter H. McGuire, George J. Engelmann, Lewis S. McMurtry, J. McFadden Gaston, Bedford Brown, Cornelius Kollock, Louis McLane Tiffany, Ernest S. Lewis, George Ben Johnston, Richard Douglas, Joseph Taber Johnson, A. M. Cartledge, Manning Simons, W. E. B. Davis, J. Wesley Bovée, Floyd W. McRae, Lewis C. Boshier, George H. Noble, Howard A. Kelly, F. W. Parham, Stuart McGuire, W. O. Roberts, Rudolph Matas, J. M. T. Finney, John Young Brown, John W. Long, Bacon Saunders, Thomas S. Cullen, W. D. Haggard, Jr., I. S. Stone, James E. Thompson, Willard Bartlett, Randolph Winslow, C. Jeff Miller, James F. Mitchell, LeGrand Guerry, Irvin Abell, Hubert A. Royster, Guy L. Hunner, Arthur C. Scott, Lucius E. Burch, James M. Mason, Hugh H. Trout, Robert S. Cathcart, Vilray P. Blair, Frank K. Boland, Robert L. Payne, Harvey B. Stone, Fred W. Rankin, Lloyd Noland, Albert O. Singleton and John Staige Davis.

Twenty-four of these are still living and more or less active in attendance and participation in the programs of the annual sessions. Those who have passed away represented, as do those who now survive, the cream of the surgical profession of the South, as well as the high grade of American surgery in their day.

The long and remarkably efficient services of Mr. William Whitford, official reporter of the Association for thirty-four years, deserves notice. He covered every meeting, except the first one, until his

death, which occurred suddenly while he was on his way to the annual meeting. For so many years he had been reporting the proceedings of the Association that he knew every one of its Fellows, took an intimate interest in its affairs and loved its traditions. The Association honored itself by including in the 1923 Transactions a memoir of this devoted official, who in season and out, in sickness and in health, until the end came, was always at his post of duty.

Without question the leading figure of the Association during his life-time was William Elias Brownlee Davis. For many years following his death in 1903, his plans and policies were carried on by those who had been with him from the beginning; and even now his spirit pervades the organization and preserves its principles. A recital of his achievements in the early days has already been portrayed in this sketch. To Davis is due the sole merit for the conception, organization and promotion of the Southern Surgical Association, and, above, all, devotion to its purposes and ideals. He gave unstinted praise to those loyal colleagues who stood by him during the lean years; and yet, but for the encouragement, enthusiasm and energy of the dynamic Davis, the Association would not have been born nor would it have survived. Those of us who knew him will not forget his capacity for work, his genius for administration and the force of his personal magnetism, which at once attracted to himself those imbued with like motives, and as readily won over any who might differ in methods. Dr. Davis "was recognized as a surgeon of clear conception, marked conservatism and unusual skill . . . especially interesting were his various articles upon intestinal surgery." In 1892, by experiments on dogs he established the practice that transperitoneal drainage of the common duct was a safe proceeding and that, after removal of calculi, "suture of the duct was unnecessary and, indeed, harmful." This was the first observation of its kind and Dr. Davis

received full honor for it from American surgeons. Thus, the real Founder of the Association on his death at the early age of forty years, was acclaimed both a professional organizer and a scientific surgeon.

We have spoken of traditions. The Southern Association in itself is a tradition. This unique organization was conceived in the unselfish devotion and faith of the fathers and born in a righteous regard for the highest aims of surgical science. Now nearing its fifty-fourth year of existence, the Association remains true to its original ideals; not for one moment has it departed from the spirit of the principles laid down by its Founders.

What are the factors which have kept us true to our origin, that have knit us closely together and still set us apart from all other professional societies? We love to believe that it is because we are a guild whose brothers are bound in a concurring purpose to relieve suffering, to put away death, to grow in scientific grace, to add to the world's weal. We have stood always

for these things, and we will stand for them to the end. We are persuaded, also, that exploitation has never entered our threshold, and that no low or selfish interest whatever has guided our thought. Can more be said? Yes, this: Paramount and pre-eminent in the very warp and woof of the Association is an inherited tradition, gathered in the souls of the Founders, gaining momentum through the decades and going on to its flower in the lives of us all. That tradition is not visible on the printed pages of the constitution and the by-laws; neither can it be discovered in rules, resolutions or reports. It exists in the minds and hearts of the Fellows, comrades in reverence for the truth. That tradition is the tie that binds us. It is honorable; it is sacred; it is immortal.

The Southern Surgical Association, sectional in name only, national in scope, world-wide in aim, joins its sister societies in a united effort to foster the high character of our profession and to uphold the supreme standards of surgery.



THE AMERICAN SURGICAL ASSOCIATION

ELLSWORTH ELIOT, JR., M.D.

Consulting Surgeon, Knickerbocker and Presbyterian Hospitals

NEW YORK, NEW YORK

AT a meeting in Atlanta of the American Medical Association in 1879, Dr. S. D. Gross, of Philadelphia, in an informal conference of prominent surgeons from different parts of the country, suggested the organization of a national society which should be entirely independent of the surgical section of the American Medical Association, and which should have for its object, "The cultivation and improvement of the art and science of surgery, and the promotion not only of the interest of the Fellows, but of the medical profession at large." He again referred to this subject in his autobiography: "Its object is to foster surgical art, science, education, and literature, to cultivate good feeling in the profession, and to unite the prominent surgeons of the country in one harmonious body."

With the enthusiastic approval and co-operation of those who were approached, the American Surgical Association came into being and Dr. Gross served as its first president. In his biography Dr. Gross merely emphasizes the objects of the proposed association and does not give the slightest intimation of any dissatisfaction with the conduct of the surgical section of the American Medical Association nor of its service as an exponent of the progress of the science of surgery in this country. It is not unlikely, however, that he believed that a society, composed of a limited number of surgeons of national reputation, would prove more conducive to the stimulation of surgical advance than the necessarily cumbersome section of the national association. At all events, at the meeting in Philadelphia in 1882, he vigorously denied that the recently organized association would adversely affect the position of the American Medical Association and stated

that there was ample room for both, and that in fact—a prophecy which has been fulfilled—the latter association would be distinctly strengthened. Furthermore, he added: "We hope to make the American Surgical Association an altar upon which we may annually lay our contributions to science and so show to the world that we are earnest and zealous laborers in the interest of human progress and human suffering."

It might seem that the rapid expansion which the art of surgery enjoyed as the result of the application of antiseptics, as advocated by Lister in 1867, might well account for the organization of additional societies, including the birth of the American Surgical Association to provide a more thorough consideration of surgical topics. Such an inference, however, is erroneous for the introduction of "Listerism" encountered general hesitation and scepticism both in this country and abroad. This was due in part, at least, to the failure to demonstrate actually the presence of the organisms of infection, and to the fact that Lister had merely conceived that the bacterial origin of fermentation and putrefaction, discovered by Pasteur in 1861, might readily account for wound infection. Therefore, the application of this "new-fangled" theory to the treatment of wounds had a very restricted scope for some time, and the rapid expansion of surgery for which it was ultimately responsible did not take place until some years had elapsed after the organization of the American Surgical Association.

The delay in the adoption of Listerism in this country is well shown in the discussion of an excellent paper of Watson, of Jersey City, advocating its use, which was presented in 1883 at one of the early meetings



The Gross Clinic by Thomas Eakins (1844-1916)

of the Association, in which surgeons of New Orleans, Mobile, Philadelphia, Chicago, Albany and New York united in stating that Listerism at that time was practiced neither by them nor by any of their colleagues. Prior to that year, at least, the prevalence of wound infection still continued to restrict the practice of surgery in this country, and surgeons of the highest reputation did not hesitate to engage in the practice of general medicine. Even Gross, in a paper published in the American Journal of Medical Science, in 1876, three years before his conception of the American Surgical Association, acknowledged that the American surgeon, as a separate and distinct class did not exist, and that "It is safe to affirm that there is not a medical man on this continent who devotes himself exclusively to the practice of surgery."

The American Surgical Association was duly organized in 1880 at a meeting in the College of Physicians and Surgeons in New York, with Lewis Sayre, president of the American Medical Association, in the chair. Officers were elected and a temporary constitution adopted. This meeting immediately followed the annual meeting of the American Medical Association, probably to insure the presence of as many as possible of those who had been invited by a committee appointed for that purpose to join in the new surgical "venture." Dr. Gross, in his autobiography, says that "The attendance was slim, not one of the prominent surgeons of New York being present."

Evidently the new Association did not meet with the approval of either Henry B. Sands or T. M. Markoe, who were then professors of surgery in the College of Physicians and Surgeons. This was even more true of Boston, for not a single surgeon of that city appears in the list of original members, though four (Cheever, Fildes, Gay and Warren) were elected to active membership in 1882. At this meeting forty-eight surgeons signed the constitution and became the original Fellows. In 1881, the meeting was held in Richmond, Virginia,

again, presumably to insure a full attendance, directly after the meeting of the American Medical Association. Only nineteen Fellows were present and no papers were read.

In September of the same year (the only year in which two meetings were ever held) the third meeting, held at Coney Island, New York, was attended by eleven Fellows. Five papers were read and discussed and Dr. Gross was re-elected president for the third time. Coney Island in 1881 was very different from the popular resort of to-day, and consisted chiefly of a bathing beach and a summer hotel of frame construction with accommodations for a limited number of guests. This meeting was the first to be held without the aegis of the American Medical Association which may have accounted for the smallest attendance ever recorded; only one-fourth of the Fellows registered. In the following year, 1882, at the meeting in Philadelphia, twenty-five Fellows registered and fifty additional Fellows were elected to active membership and at the same meeting seven surgeons were elected Honorary Fellows. This included P. J. Horwitz and William Hunt, of Philadelphia, John L. Atlee, of Lancaster, Pennsylvania, and Willard Parker, Alfred C. Post, J. Marion Sims and Stephen Smith, of New York. The first foreign surgeons to be elected Honorary Fellows in 1885 were Thomas Annandale, of Edinburgh, John Eric Erichson, Victor H. Horsley, Lord Joseph Lister and Sir James Paget, of London, A. S. Verneuil, of Paris, F. von Eschsch, of Keil, J. N. Nussbaum, of Munich, Richard von Volkmann, of Halle, and the noted A. C. Theodore Billroth, of Vienna. Since that year many other distinguished surgeons abroad have accepted Honorary membership, although Henry J. Bigelow, of Boston, in 1886, and two original active Fellows, Edward M. Moore and David W. Yandell in 1896, who served respectively as president of the Association in 1883 and 1889, are the only additional American surgeons to be included in the list. At this same meeting,

notwithstanding his vigorous protest, Dr. Gross was elected president for the fourth time. Four papers were read and discussed, the larger part of the meeting being occupied in the perfection of the organization. In 1883, forty Fellows registered at the meeting in Cincinnati and a number of prominent surgeons were elected to membership bringing up the number of Fellows to almost one hundred, the number originally provided for by the constitution.

As Dr. Gross steadfastly refused re-election as president, Dr. E. M. Moore, of Rochester, New York, was elected his successor. During its entire existence Dr. Gross is the sole Fellow who has served more than one term as president and after he voluntarily retired from office he was the recipient of a well deserved testimonial of appreciation, tendered unanimously by his fellow colleagues for the distinguished services he had rendered. After this meeting Volume I of the "Transactions of the Association" was published, containing all papers and discussions presented up to that time.

In 1884, at the meeting in Washington, forty-three members registered. The Association has successfully weathered its early years and has become firmly established. Membership in its ranks is eagerly, though not always successfully sought and is considered a great honor. In 1886, the Congress of American Physicians and Surgeons was organized, composed of nine National American associations, of which the American Surgical Association was one. They planned to meet once in three years in the city of Washington. The meetings of this congress are now held once in five in place of three years. This change was made shortly after the conclusion of the World War.

In 1891, a committee of twenty-six Fellows was appointed to promote the erection of a monument to Dr. Gross in the city of Washington. The efforts of this committee were ultimately successful and in 1897 a statue of Dr. Gross was unveiled in that city with appropriate ceremonies.

At the time of its organization the membership of the association was limited to one hundred active Fellows. In view of intermittent efforts to increase this membership, which both the constant growth of the country and the uninterrupted expansion of surgery seemed to justify, it is of interest to note that as early as 1883 an amendment, offered the preceding year, to increase the membership to one hundred fifty, failed to pass, on the ground that the association would thereby be rendered unwieldy. The "pressure," however, became so pronounced that in 1900 it was voted to increase the membership to one hundred twenty, and at the subsequent meeting twenty additional Fellows were elected. These included the first Fellows elected from Canada. Dr. Armstrong and Dr. Bell, of Montreal, received that honor. At the present time both Montreal and Toronto are notably represented, although no Fellow has ever been elected from Quebec.

This additional membership relieved the "pressure" only temporarily. Many desirable candidates failed of election, or were elected only after considerable delay. Vacancies occurred only through death or resignation. With few exceptions in the early years of the Association resignation was rare and was usually due to the retirement of a Fellow from active practice. In 1909, to increase the number of vacancies, those who had been active Fellows for fifteen years and had reached the age of sixty-five were entitled to become "Senior Fellows." The transactions of that year included, for the first time a list of twenty Senior Fellows and their number has steadily increased until, at the present time, there are ninety-four. The transfer of active Fellows to the senior group is now recommended by the Council of the Association without reference to either age or to the length of membership. That the urge for membership still continues, however, is reflected in the nomination of nineteen candidates at the last meeting. Since 1909 the number of active Fellows has been increased to one hundred fifty, and lately to

one hundred seventy-five. The Association has, therefore, become more "unwieldy" than was anticipated in 1883, though the interest and scientific value of the annual meeting has steadily increased.

The American Surgical Association is admittedly the premier surgical Association in the western hemisphere. To be elected a Fellow is a great honor; to fail of election is no disgrace. During its entire existence it has steadily maintained the objects which were designated by its founder, Dr. Gross. On its "altar" have been placed without reservation the most noteworthy contributions which its Fellows have made to the art and science of surgery. It has steadfastly promoted surgical education, the teaching of surgery, and what its founder never anticipated, it has been most

influential in insisting upon rigid qualifications for those who wish to exchange a career as a general surgeon for one more restricted, and sometimes more conspicuous, in some surgical field. It has constantly emphasized the desirability of a training in general surgery as an essential prerequisite, and has frowned upon those who, without such qualification, would pose as surgical specialists. It exercises not only these various essential duties, but, what is of equal importance, it insists upon the maintenance of the highest ethical professional standards. It fosters friendship and intimacy and has admirably fulfilled the expectations of its founder in promoting the mutual interests of its members. Long may it survive and continue to carry forward the torch of progress of the art and science of surgery!



Man of the Year 1940. Dr. Fred H. Albee has been selected as the Man of the Year 1940 by the Greek Fraternity Kappa Sigma. Dr. Albee received this award at a Founder's Day Banquet held at the Carlton Hotel, Washington, D. C., on December 10, 1940.

THE AMERICAN GYNECOLOGICAL SOCIETY

GEORGE W. KOSMAK, M.D.

Editor, American Journal of Obstetrics and Gynecology

NEW YORK, NEW YORK

ON June 3, 1876, a group of men from various parts of the United States gathered in the building of the New York Academy of Medicine in response to a summons for the founding of an organization for the advancement of obstetrics and gynecology in this country. The three men primarily responsible for the movement were Paul F. Munde, of New York, J. Tabor Johnson, of Washington, and James R. Chadwick, of Boston. At this first meeting a committee was appointed to draw up a constitution and by-laws and another committee to propose a list of officers, who were unanimously elected. These were Dr. Fordyce Barker, the first president, Dr. Atlee and Dr. Byford, vice-presidents, Dr. Chadwick secretary, and Dr. Munde, treasurer. The original Fellows numbered thirty-nine and the first annual meeting was held in New York, September 13 to 15, 1876. The celebration of the centennial of the Nation's founding was deemed an appropriate time to recognize the claim to pre-eminence which America could make with justice in this particular department of medicine. It was decided to maintain a restricted membership and require high qualifications of its candidates for admission, both personal and scientific, so that "the fellowship would be coveted and the discussions be more profitable."

The two topics which were voted as suitable for special consideration at this first annual meeting were: Incision of the cervix uteri and the after-treatment of ovariectomy. A Volume of Transactions was provided for and Dr. Billings, of the Surgeon General's Library in Washington, was commissioned to obtain for each volume a complete index for the twelve preceding months. These Transaction volumes present a very full record of the

development of American obstetrics and gynecology from 1876 to the present time, and show the extensive participation of the Society's Fellows in the great work of making the combined specialty an integral part of American medical achievement. We find as contributors to the programs of the annual meetings the names of many who have attained fame, men whose names should be familiar to all students of medicine. Some of these names have survived in the appellations given to various operative procedures, diagnostic methods, instruments and, though many have been forgotten in the passage of the years, their cumulative labors have contributed to place American gynecology and obstetrics on the high plane which it now occupies.

The American Gynecological Society probably was the first national organization of its kind either here or abroad. Perhaps the only groups which antedate it are the Boston Obstetrical Society, founded in 1861, the New York Obstetrical Society, 1863, and the Philadelphia Society, 1868. Included in its Fellowship, both active and honorary, have been the leading men of our specialty both here and abroad. Among the latter have been the invited guests from foreign countries whose contacts with their American confreres have done much to cement the bonds of mutual interest and friendship which are so essential to the progress of the liberal sciences, including medicine.

Within the limit and scope of this brief presentation it is not practical or feasible to detail the work of the Society or its Fellows. All of this is fully recorded in its accumulated transactions which have been published uninterruptedly for the entire period of its existence both in special

volumes issued by the Society and in the pages of the American Journal of Obstetrics and Gynecology. These Transactions constitute an enviable record and their perusal would well repay the attention of American physicians and medical students. They demonstrate very conclusively the time, thought, devotion and labor which have been contributed to the advance of obstetrics and gynecology by the workers in this important specialty of medicine. "The latter is no longer that narrow art practised by its devotees with knowledge gained by hearsay, surrounding itself with a mantle of secrecy and holding itself aloof from the world at large."

Medicine today has entered intimately into the life around us; in fact, it is a part of the same. While still essentially individualistic, medical practice today has a

widespread social and community interest, and national organizations of specialists in particular have a responsibility aside from their immediate sphere of activity which, fortunately, they have recognized and stimulated. The American Gynecological Society through its Fellows has participated actively in this development and has served as a stimulus to the formation of other similar organizations throughout the country which have elevated the appreciation and importance of our specialty.

The Society has kept pace with the development of medical art and science in the United States and has afforded opportunity for the presentation of clinical and research problems through an uninterrupted series of annual meetings, the programs of which constitute an enviable record in the progress of American medicine.



Book Reviews

EXPECTANT MOTHERHOOD. By Nicholson J. Eastman, M.D. Boston, 1940. Little, Brown and Company. Price \$1.25.

It frequently happens that a prospective mother has no end of questions which she asks her physician. Some of them are relevant and many seem trivial but every one of them demands an answer. Often the time consumed in meeting these demands takes a lot of the physician's time. Therefore, although several such short books have been published during the last quarter century, this modern, sanely and beautifully written book fills the bill in every detail. It tells the expectant mother (not to mention her husband) everything one could want to know concerning all the whys and wherefores of the pregnant state. Many physicians are sure to recommend it to their patients, and in our opinion it is the best book at hand on this topic. That it is authentic goes without saying, as the author is Professor of Obstetrics at Johns Hopkins University.

ATLAS OF CARDIOROENTGENOLOGY. By Hugo Roesler, M.D., F.A.C.P. Springfield, Ill., 1940. Charles C. Thomas. Price \$8.50.

This atlas is a case-history type of presentation, with the case protocols and a short comment making up the only text. While the atlas is primarily one of roentgenology, it is intended more for the clinician than the radiologist, and presents a fine correlation of clinical, laboratory, radiographic and pathologic findings. The illustrations are excellent and are by no means confined to radiographs. The plates of pathological specimens are particularly abundant, and Dr. Roesler's method of demonstrating the cardiac pathology by longitudinal and window sections is of special interest. The book should be instructive to both the student and the cardiologist.

A TEXTBOOK OF SURGERY. By John Homans, M.D. Compiled from Lectures and Other Writings of These Members of The Surgical Department of The Harvard

Medical School (twenty-three authors are named). Springfield, 1940. Charles C. Thomas. Price \$8.00.

Any one, surgeon or medical student, who wishes a "good" work on surgery, either for reference or textbook, will go far afield to find one that measures up to this book. It is nine years (1931) since the first edition appeared, and during that time Dr. Homans and his co-authors have kept their work in the front rank of surgical textbooks.

It is unnecessary to go into details. Suffice it to say that basically the work is authentic and fulfills in every detail the requirements of a book of this type. The authors have also kept it up-to-date. Dr. Homans in his Preface to the Fifth Edition explains how Harvey Cushing fathered the method of keeping a book alive. This book, containing 1272 pages, 530 illustrations by Willard C. Shepard, and a special bibliographical index, is worth a score of the usual run-of-the-mill surgical works usually written to complete a publisher's lists.

SHOCK: BLOOD STUDIES AS A GUIDE TO THERAPY. By John Scudder, M.D. Philadelphia, 1940. J. B. Lippincott Company. Price \$5.50.

Surgeons, especially, should read, reread and digest the contents of this volume. It deals with "the importance of the chemical approach to certain of the fundamental biological problems encountered daily in our Surgical Service" (Allen O. Whipple in the Foreword). Dr. Whipple further states that it gives him great pleasure "to acknowledge the beneficial results of our surgical patients before and after operation because of his [Scudder] studies. These have developed methods and a critique which have been of the greatest therapeutic value to the Surgical Department of the Presbyterian Hospital." The work is divided into four Parts. Part One deals with the historical and experimental; Part Two with varieties of shock—their analysis and treatment; Part Three with historical development and bibliography; and

Part Four with a laboratory manual. Every section is valuable but the student with a basic background in this work will find Parts Two and Three especially interesting, while the hospital surgical chief will put his juniors to the task of becoming familiar with the facts contained in Part Four. Inasmuch as every surgeon has patients who suffer from shock, notwithstanding the apparently endless list of books and articles that have been written on this subject, we would urge that this work be acquired and thoroughly studied.

FRACTURES AND OTHER BONE AND JOINT INJURIES. By R. Watson-Jones, F.R.C.S. Baltimore, 1940. The Williams and Wilkins Company. Price \$13.50.

This is several books in one, . . . a book for the fracture specialist, general surgeon and practitioner who must meet emergencies and handle fractures and other bone injuries. It is hard to review in as much as there is nothing to criticize. It is not our place to quibble over minor problems of technique. In every detail *Fractures and Other Bone and Joint Injuries* is, one might say, "the last word on the subject." The work covers the material in detail and is very well written. We would draw special attention to the illustrations, some of which are in color, the work of Douglas Kid. They are far above the average. Anyone desiring a book on fractures and bone injuries would not be disappointed should he add this one to his library.

NEOPLASTIC DISEASES. A TREATISE ON TUMORS. By James Ewing. Fourth Edition. Revised and Enlarged. With 581 Illustrations. Philadelphia, 1940. W. B. Saunders Company.

What can a reviewer say of Dr. Ewing's work, now in its fourth edition, completely revised and enlarged, other than that it is one of the best if not the very best book in its field. This reviewer believes nothing finer has been written in the English language on neoplastic diseases. The first edition appeared in 1919, and other editions were brought out in 1922 and 1928. During the past decade we witnessed additions in many branches of neoplastic disease, and the author, being abreast of all new knowledge on the subject, has virtually redone his book. It is up to the minute and that it is scientifically the last word, goes without saying.

A library would be incomplete without this valuable work on its shelves.

CLINICAL UROLOGY. By Oswald Swinney Lowsley and Thomas Joseph Kirwin. Two Volumes. Baltimore, 1940. The Williams & Wilkins Company. Price \$10.00.

The authors have written a readable, scientifically sound and worth while book in two volumes. It was written for all physicians, the medical student, the general practitioner, the general surgeon, not to mention its scope as a reference work for the trained urologist. The subject is covered most satisfactorily. There is to be nothing gained by going into detail. Suffice it to say that any physician, specialist, or practitioner, who requires a work on Clinical Urology, will have his every desire fulfilled with this work.

We also noted the size of the books are such that they feel good in the hands. The print is clear and large enough to make reading easy, and the illustrations by William P. D. Busch are superb. Some of them are in color.

We congratulate the authors and the publishers in giving the profession such an interesting and scientifically sound set of books on Clinical Urology. It is an important contribution to the literature of this subject.

THE HEAD AND NECK IN ROENTGEN DIAGNOSIS. By Henry K. Pancoast, M.D., Eugene P. Pendergrass, M.D. and J. Parsons Schaeffer, M.D. Springfield, Ill., 1940, Charles C. Thomas. Price \$12.50.

This is a large book consisting of 976 pages. There are 1,251 illustrations, some of which are in color. These illustrations are clear and are necessary to the text. The paper used is of a high grade; therefore, anyone who knows the barest fundamentals of publishing will realize that the cost is modest under the circumstances. But more important, this work is beyond value to the roentgenologist, surgeon, neurologist, neurosurgeon, otolaryngologist, ophthalmologist, endoscopist and many others who dwell in circumscribed fields of medicine. The work is a complete correlation and integration of anatomical, physiological, pathological, clinical and roentgenological observations. It is beautifully prepared and a book which we earnestly recommend.

The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LI

FEBRUARY, 1941

NUMBER TWO

Editorials

SURGICAL TRAINING AND ACTIVE MILITARY DUTY

A YOUNG MAN, connected with the Reserve Officers Training Corps, I have been an intern for two years, served time in the department of pathology and then contracted to put in three years more as assistant and then senior resident in a hospital affiliated with a medical school. Inasmuch as he will not finish his residency until next October and is most anxious to do his bit, he has been taking special courses in order to fit himself better when he receives a commission. Out of a clear sky he received a notice to signify when in the near future he would be ready to report for active duty. This order upset him greatly. It upset the hospital and college authorities, also. The young physician was disturbed because he had put in several years of hard, routine work in order to get the last year of the residency, which provides him with an opportunity to do a lot of surgery under expert supervision. When his term ends, he will be eligible to take his American Board examinations and practice his specialty. If he has to drop his work right in the middle of it, he will lose valuable experience and probably never get an opportunity to complete his service as a senior resident. Maybe, years from now, he will not be eligible to take his Board tests. The college and hospital authorities were upset because this young man had been trained to do particular work for which he

was fitted by experience, and to teach sections of medical students. To have him taken away in the midst of his work would upset the apple cart no end.

Several people got busy to find out what could be done about it. As this is written the answers have been unsatisfactory and ambiguous. Had the young man not been in the Officers Training Corps, but had a draft number, the procedure would be simple. In that case, if called, he would ask and no doubt be granted deferment. It seems that had he resigned from the Training Corps several months ago he would have been subject only to the draft. But being in the Officers Training Corps, and in apparent good standing, he is caught up in a mesh of red tape. He has been told that now he cannot resign. He might get a postponement of six months and at the end of that time another postponement. However, another person, who wears a lot of braid, says that if the young doctor is called he will have to drop everything pronto and report on the dot. There will be no postponements. The government may be interested in the training of interns and deem such training necessary, but being a resident means nothing from any angle.

We learned (second hand) that many of the deans of medical schools are trying to do something "about it." Various "heads of departments" sought information from

Colonel This and General That; telegrams were sent here and there (we had our resident send one asking for a reply by telegram, collect; this has not been answered to date); and all the replies and information varied, leaving one in doubt as to just what the truth is.

There are many young men throughout the land who have six months to a year and a half to complete their residencies. Many of these men gladly joined the Officers Training Corps, and when their term as resident is over, they want to receive a commission and do more than their bit. Inasmuch as they will be the physicians and surgeons the country will have to depend upon in the future—the men from whose ranks the leaders will emerge—and as teaching institutions and hospitals will be adversely affected, should these men be

taken from their work? We hope “those in command” at Washington will clear up the situation and let both the residents and hospital and college authorities know just where they stand and what to expect.

No doubt within twenty-four hours after this is read we will receive letters telling us how easily this information can be ascertained. Either no one has to be apprehensive or—move heaven and earth—these young men will have to go, training or no training; but we do know the telephone and telegraph wires have been hot, and in the end, like Omar Khayyám we “came out of the same door wherein we went.”

We believe it would be common sense to permit these young men to finish their residencies before being ordered to report for active duty.

T. S. W.

VAN METER PRIZE AWARD

THE American Association for the Study of Goiter again offers the Van Meter Prize Award of Three Hundred Dollars and two honorable mentions for the best essays submitted concerning original work on problems related to the thyroid gland. The award will be made at the annual meeting of the Association which will be held at Boston, Massachusetts, May 26, 27 and 28, provided essays of sufficient merit are presented in competition.

The competing essays may cover either clinical or research investigations; should not exceed three thousand words in length;

must be presented in English; and a typewritten double spaced copy sent to the Corresponding Secretary, Dr. W. Blair Mosser, 133 Biddle Street, Kane, Pennsylvania, not later than April 1.

The Committee, who will review the manuscripts, is composed of men well qualified to judge the merits of the competing essays. Dr. Brien T. King, of Seattle, Washington, received the award for the year 1940 in recognition of his essay entitled “A New and Function Restoring Operation for Bilateral Abductor Cord Paralysis.”



Original Articles

THE MANCHESTER OPERATION*

WITH SPECIAL REFERENCE TO ITS DEVELOPMENT AND THE PRINCIPLES INVOLVED
IN ITS TECHNIC

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NEW YORK, NEW YORK

THE problems associated with uterine prolapse have held for the gynecologist an interest which has existed over a period of many years. This has resulted in numerous and definite achievements. Chief among these, is the marked reduction in the occurrence of this condition and the development of an operative procedure which not only restores the prolapsed pelvic organs to their normal position and relationship, but reestablishes their physiologic function as well.

The treatment of uterine prolapse, previous to the period of operative procedure, often proved to be a difficult and intricate problem. The retaining pessary, being the sole means of treatment, was rendered useless when tissue control was inadequate. This fact naturally led to operative attempts towards securing support for the pessary. Some of these were directed toward utilizing the tissues of the anterior vaginal wall, while others advocated the use of posterior colporrhaphy. However, neither of these operations proved to be of great value.

Donald of Manchester, appreciative of the inadequacy of these operations as separate procedures, and also recognizing the need of more permanent support without the use of the pessary, decided to combine these operations with amputation of the cervix, and in so doing, accomplished

an operative technic which has, with slight modifications, been used successfully over a period of fifty years.

It might be of interest at this point to review the history of Donald's early cases which are so ably described by Shaw¹: "About this time he heard that in Germany a new absorbable suture material, catgut, was being tried in general surgical work, and having obtained some, sterilized in carbolic oil, he performed his third operation on August 3rd, 1888. In this case he did an anterior colporrhaphy with a wide diamond shaped incision, and drew the deep tissues together with a buried spiral suture of catgut. A fortnight later a posterior colporrhaphy was performed and the deep tissues as in the anterior colporrhaphy, closed with buried catgut. On August 30th, the patient was discharged and to quote from the notes: 'The wound was healed and the outlet of the vagina only admitted two fingers with difficulty. No pessary was inserted.'

"Two other patients were operated upon in that year making five in all, the same number in 1889; six in 1890; and only three in 1891, but the results were obviously improving and he was gradually becoming convinced that this operation could be used as a cure and not merely as a means to retain a pessary, as there is a note to each of the cases in 1891, that the patient went

* Presented before the Obstetrical and Gynecological Section's Annual Meeting of the New Jersey Medical Society, June 4, 1940.

home without a pessary, whereas, in previous years this note was only added to one case in each year.

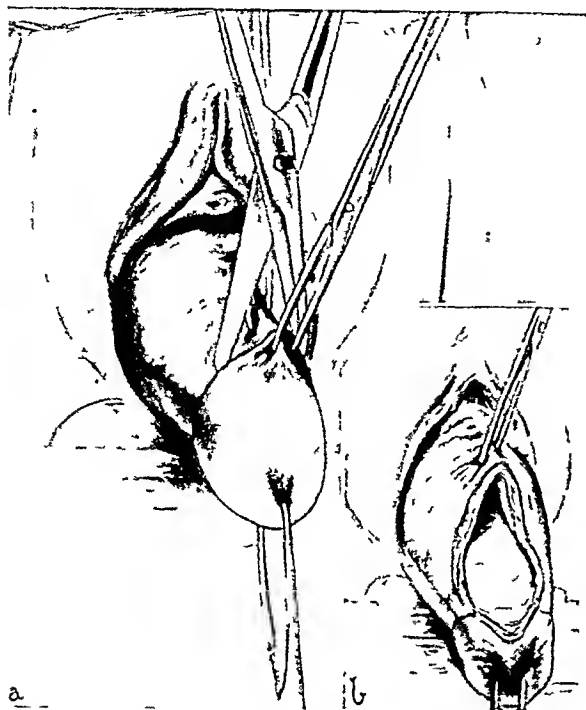


FIG. 1. A, the opening of the anterior vaginal wall B, the entrance to the line of natural cleavage between the vaginal and bladder walls. (From Goff, Byron H. An evaluation of the Bissell operation for uterine prolapse. *Surg., Gynec. & Obst.*, 57: 762-771, 1933.)

"In all these cases anterior and posterior colporrhaphy were combined and in a large number the cervix also was amputated."

The operation, mainly on account of its many contributors, has assumed a varied nomenclature, commonly known as the Manchester operation. It is also spoken of as the Donald operation, the Donald Fothergill operation, the Shaw operation; and Frank in this country in describing a variation in technic, wrote of it as Parametrial Fixation. In a recent conversation with Dr. Frank, he expressed a desire that this operation be known only as the Manchester operation, in respect to its origin in that place.

In reviewing the literature of the Manchester operation, one cannot help but be impressed with the variations in terminology describing the tissues essential to the operation. Needless to say this is confusing

to those unfamiliar with its technic. It is probable that the various authors have the same basic principles in mind but differ in their anatomic terminologies. This fact may explain why some operators fail to utilize the essential features of the operation and may also account for some of the failures in which the technic apparently has been followed. In a recent communication from Shaw he wrote, "Some of the operations which are seen and which go by this name, are not a bit like the original and do not even follow the same principles."

According to Bissell² and many other observers, the uterus is suspended in its normal position by the visceral portion of the fascia endopelvenia. This fascia projects inward from the sides of the pelvis and joins the cervix at the level of the internal os. It extends from the base of the broad ligament and mixes with the smooth fibers of the uterine muscle. Added support is given to the posterior portion of the cervix from the posterior fibers of fascia endopelvenia. These ligaments are commonly known as the transverse cervical, cardinal or ligaments of Mackenrodt.

It is important, in considering uterine prolapse, to bear in mind the various degrees of prolapse. As is well known, the cervix in this condition becomes elongated and hypertrophied with an accompanying relaxation of the cardinal ligaments. The internal os, therefore, becomes the landmark.

According to Goff,³ "When the uterus has descended so that the internal os is at the midpoint of the vagina, as the patient strains, the prolapse has been termed first degree. When the internal os is at the level of the vulva, the prolapse has been termed second degree, and when the entire body of the uterus has passed beyond the introitus, the prolapse has been termed third degree." One might add to this classification that where the cardinal ligaments tend to show a relaxation with an accompanying retroversion, it might be termed a half degree prolapse.

That amputation of the cervix, in conjunction with support of the uterus, was a

necessary factor in curing prolapse, was realized by Donald at a very early period in his work. This is shown in Shaw's review of

"The cervix was amputated as the first stage and silver wire was used to bring the cervical flaps together. (This was the last

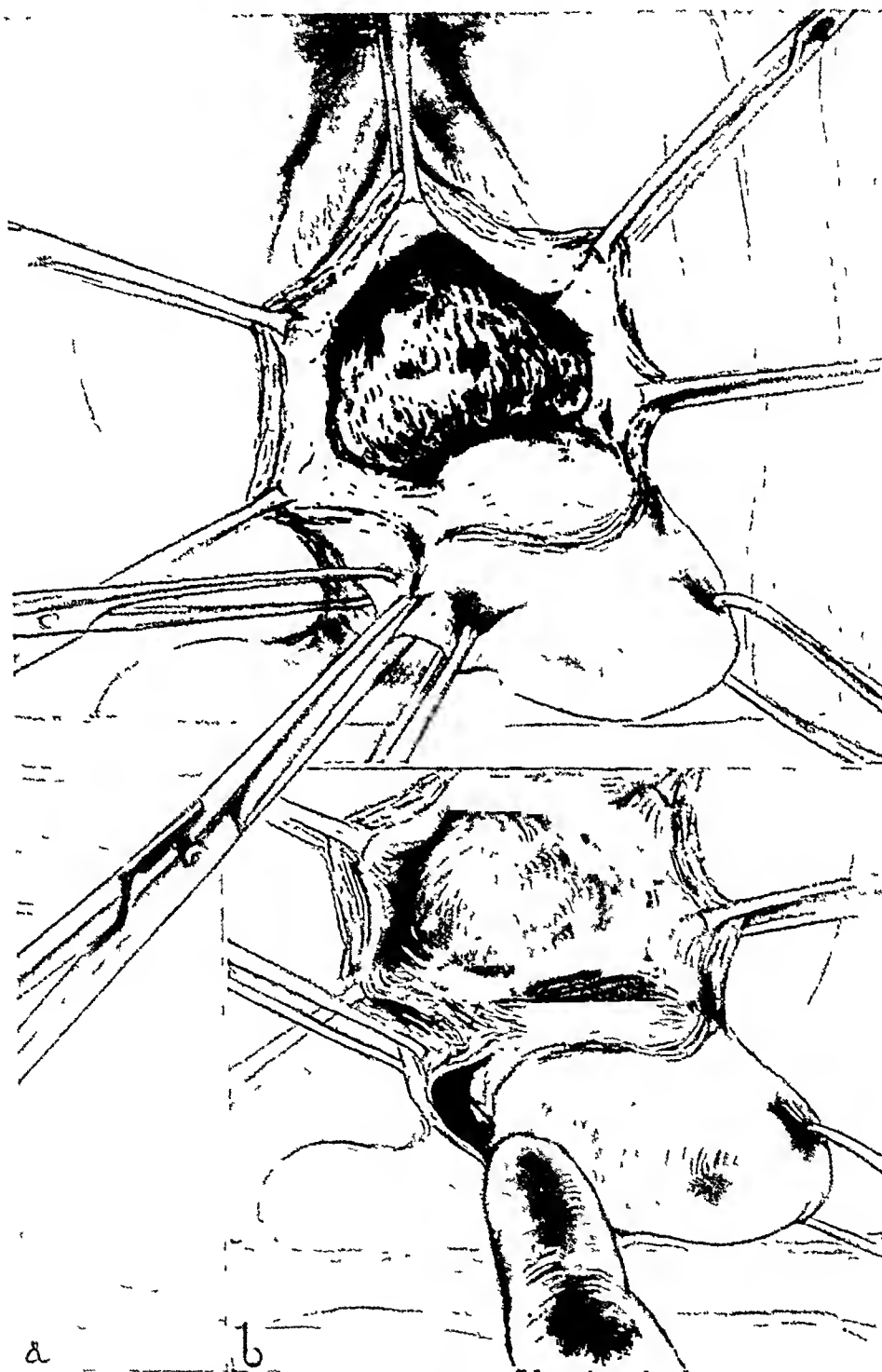


FIG. 2. a, the bladder has been separated from its abnormal cervical and vaginal attachments. The lateral incision of the vaginal wall. b, the approach to the transverse cervical ligament. (From Goff, Byron N. An evaluation of the Bissell operation for uterine prolapse. *Surg., Gynec. & Obst.*, 57: 762-771, 1933.)

Donald's early cases and again by Donald⁴ in his description of his second case operated on July 30, 1888:

occasion in which I used silver wire for the cervix.) The anterior and posterior colporrhaphy followed. The raw surface was

diamond shaped on the anterior vaginal wall, and was stitched with catgut continuous and buried. On the posterior surface a

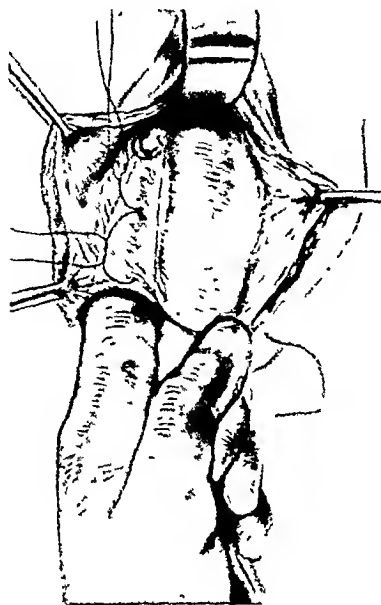


FIG. 3. The ligation of the transverse cervical ligament and uterine vessels. (From Goff, Byron H. An evaluation of the Bissell operation for uterine prolapse. *Surg., Gynec. & Obst.*, 57: 762-711, 1933.) High ligation of the cardinal ligaments and uterine vessels is not necessary in the Manchester operation.

triangle was mapped out with the apex close to the surface and the base at the junction of the skin and mucous membrane, the sides of the triangle diverged so that, at the base they reached the middle of the labium minus of each side. After the operation the vagina only admitted one finger. The posterior colporrhaphy was done in stages for above downwards, the triangular flap being separated from its apex for about an inch and then the sides brought together before the incisions were carried lower down. Buried continuous catgut was used for the deep stitches."

In discussing the details of his technic, Donald makes no mention of the cardinal ligaments or parametrial tissue as such, but lays stress on the adequate building of the anterior and posterior vaginal walls and the necessity for bringing together the deep

tissues on either side by deep buried sutures.

Alexandroff⁵ suggested an operation, which in principle was similar to Donald's but differed in the fact that the deep sutures were removed at the termination of the operation. A curved incision was made across the anterior vaginal fornix, extensive enough to allow separation of the bladder and parametric tissue. After this the parametric tissue was freed and held out of the way from the cervix on either side. When these sutures were brought together they drew the parametric tissue up in front of the cervix. Further sutures were then placed to unite these tissues not only to one another but to the anterior portion of the cervix as well. After the vaginal incision was closed the temporary sutures were removed.

Hastings Tweedy⁷ also described a similar operation but suggested opening the peritoneal cavity both anteriorly and posteriorly, and separating the vaginal well from the parametric tissue on either side.

These operations were, in the main, similar to Donald's original operation, varying merely in technical approaches and in the methods of securing the parametric tissue.

A few years later Fothergill,⁶ an associate of Donald, realized the full importance of the cardinal ligaments as the essential supports of the uterus and suggested a wider incision in the anterior vaginal wall as a means of securing the parametric tissue more adequately and suturing it to the anterior aspect of the cervix.

Fothergill, perhaps more than anyone else, stimulated interest in Donald's work and focused attention upon the importance of the cardinal ligaments as the main factor in uterine support. His accurate description of his operation emphasizes this:

"The operation is begun by cutting across the vaginal wall between the cervix and the bladder. This transverse cut extends into the lateral fornices for about one half inch on either side of the middle line. The bladder is then separated freely from

the cervix and from the vaginal walls down to about one half inch from the urethra aperture. The vaginal wall is then freely

Shaw,⁸ a pupil of Donald, read a paper in this country in 1933 on "The Treatment of Prolapse Uteri, with Special Reference to

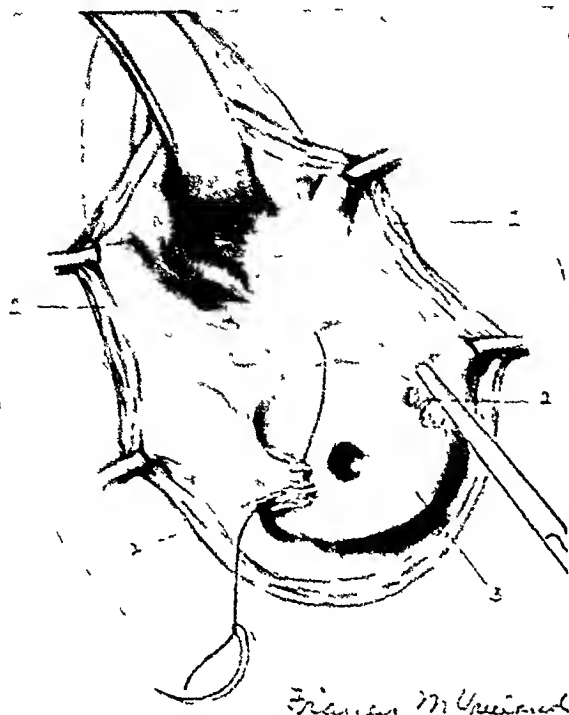


FIG. 4. Illustration showing (1) vaginal wall, (2) transverse cervical ligament, and (3) amputated cervix.

cut away. The portion removed is roughly triangular in shape, its base being at the vaginal roof and its apex one and one-half inches or so from the urethral aperture. The bladder and with its ureters is pushed well up and out of harm's way. The uterus is also pushed up into the pelvis and sutures are inserted so as to unite the parametric and paravaginal tissues to one another, and to the anterior aspect of the cervix. These sutures may be buried, or they may be made to include the margins of the vaginal wall, so that when tied they bring together the portion of the original incision which is nearest to the cervix. In either case, the result is to unite in front of the cervix certain portions which previously were widely separated and lay at the sides of the cervix and vagina. This effectively shortens the supports of the organs in question. As the lower part of the incision is closed, the sutures are made to penetrate the tissues underlying the vaginal wall, and then the paravaginal tissue is drawn from the sides to the front of the vagina."

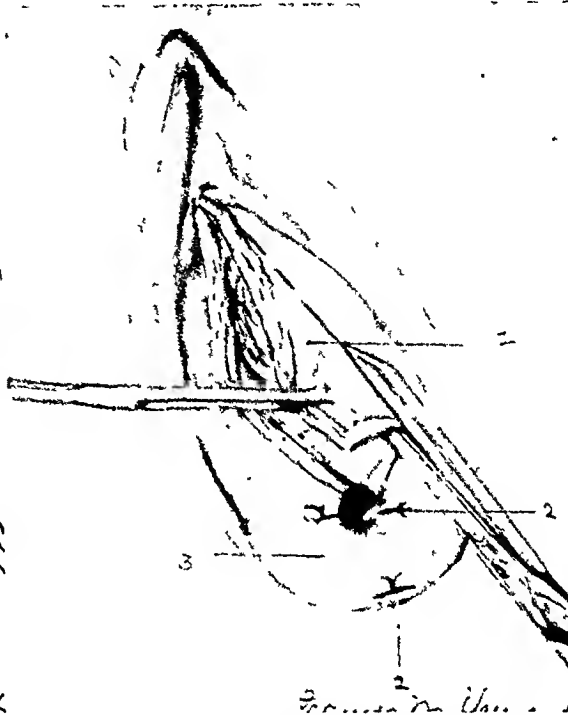


FIG. 5. Illustration showing (1) excision of vaginal wall, (2) inverting vaginal wall suture, and (3) posterior vaginal wall covering amputated surface of cervix.

the Manchester Operation." Shaw's operation, like Fothergill's, is based on the principles laid down by Donald but differed in technical approaches and methods of approximating the parametric tissue over the anterior aspect of the cervix.

Shaw refers to the parametrial tissue in his description as the muscular tissue at the base of each broad ligament: "The few fibers of muscle and connective tissue which fix the bladder to the cervix, have been cut and this organ has been dissected up from the cervix. This exposes the muscular tissue at the base of each broad ligament, and with a needle it is possible to encircle a mass of this tissue on each side. When these sutures are tied this tissue from each side will be drawn to the front of the cervix, and therefore, this portion of the pelvic floor will be shortened by this amount." Shaw very properly emphasizes the fact that if the parametrial tissue is properly sutured in front of the cervix, it will keep the uterus anteverted even if

previously retroflexed. He advises, however, that if the uterus is very heavy, it is better to transfix a portion of the anterior

mucous membrane and cervix. "The anterior wall is reconstructed by a series of interrupted sutures, starting just in front

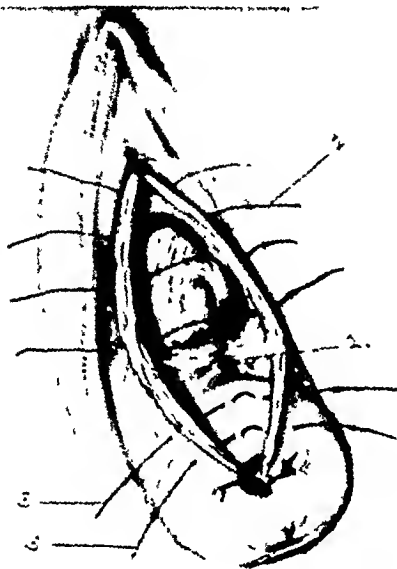


FIG. 6. Illustration showing (1) vaginal wall suture, (2) suture of parametrial tissue, and (3) suture to vaginal wall, including upper portion of amputated cervix.

wall of the uterus. Shaw believes that this operation is applicable in any degree of uterine prolapse.

Cameron's⁹ description in Maingot's surgery of the Manchester operation again varies in the technical approach; he advises using a method in which the anterior vaginal wall flap and cervix are amputated in one piece. Here the subvesical fascia is sutured to the anterior aspect of the cervix but only after being pleated on either side first. Cameron also lays stress on the suturing of the edges of the vagina to the amputated cervix, as a means of obtaining a recession of the cervix upward and backward, as the sutures are placed alternately on either side.

Alfred Gough¹⁰ suggested a modification of the Fothergill operation which removes the whole of the posterior fornix and thus shortens the vagina in the more advanced cases of uterine prolapse. Suturing is similar to the other methods after the primary sutures are placed in the vaginal



FIG. 7. All sutures have been tied and cut completing the operation.

of the cervix and advancing from behind. The needle takes a good hold of the paravaginal fibro muscular tissue as well as the vaginal wall."

Halban's¹² operation is, in general, similar to other fixation operations except in those cases in which retroversions accompany the decensus prolapse. In these he combines high vesicofixation with anterior colporrhaphy.

The steps of the anterior colporrhaphy are as follows: "A longitudinal incision extending through the mucous membrane and underlying fascia is then made on the anterior vaginal wall, and exposes the bladder. The lateral vulsella are now removed and the mucosa flaps dissected laterally by sharp dissection thus separating the mucosa from the underlying fascia. After the cut edges of mucosa and fascia have been separated by sharp dissection, the separation is continued laterally, as far as possible, by blunt dissection. This blunt dissection must be carried laterally to the levator muscles. . . . The lower end of the

vesicovaginal fascia is now dissected free from its attachment. . . . The fascia is next sutured by interrupted catgut stitches. If the cystocele is a large one, then the fascial slack is first taken up by one or more purse-string sutures. Enough interrupted sutures must be used to make a firm fascial sheath. It should be emphasized that the vesicovaginal fascia can be found and dissected free in every instance."

Frank¹¹ in this country was the first to develop a technic which differed materially from the original Fothergill operation. The technic as described differs mainly in the isolation of the cardinal ligaments and their resuturing on either side which brings the cardinal ligaments in juxtaposition with the surface of the amputated cervix. This suture is started in the mucous membrane of the lateral fornix, at a distance approximately one and one-half inches from the cut edge. The suture is carried through the base of the cardinal ligament and through the lateral wall of the cervix, the needle being brought out through the cervical canal. A bite is then taken in the mucous membrane flap, close to the cut edge and the suture is then carried through the cervical canal traversing in reverse fashion, the lateral wall of the cervix and the cardinal ligaments and piercing the mucous membrane at a distance of about one inch below the point of entry of the suture. A similar suture is introduced on the opposite side. The lateral sutures are then tied. This causes the mucous membrane flaps as well as the lateral parametria to be turned in toward the cervix.

Leventhal and Boshes¹³ have published recently a modification of the Manchester operation, and described accurately the tissue used in their operation: "The bladder is next freed from the anterior wall of the cervix and pushed upwards by blunt dissection. This maneuver makes prominent the bladder pillars. The bladder hernia is then reduced by uniting the uteropubic fascia with interrupted Lambert's sutures of catgut. . . . The bladder pillars of each side are caught between two clamps

at a level of 1 cm. above the plane of cervical amputation. The top one is placed well laterally and takes in its grasp some cervical and parametrial tissue. When ligated, this stitch includes fibers of parametrium and uteropubic fascia and marks the location for the parametrial stitches to be placed later on. The parametrial fixation stitches are next placed and include on each side the parametrial tissue just lateral to the transfixed uteropubic ligaments. Tying the fixation stitches unites the parametria in front of the remaining cervix forcing it backwards and anteflexing the corpus."

It will be noted in these descriptions the similarity of technical procedures but with a marked variation in terminology. This may be ascribed to the variability in pelvic tissue terminology, and partly to the difference of opinion among gynecologists as to the essential features involved in uterine support.

Donald refers to the "deep tissues"; Alexandroff, Tweedy, Fothergill, Leventhal, Boshes and Frank speak of the use of the parametrial tissue. Fothergill in his description refers to the parametric and paravaginal tissues. Shaw prefers to describe the parametric tissue as "the muscular tissue at the base of each broad ligament." Alfred Gough cites the necessity of securing the "paravaginal fibro-muscular tissue." Cameron stresses the importance of "suturing the subvesical fascia." Leventhal and Boshes refer to uteropubic fascia, and Frank, Leventhal and Boshes refer to the term, "pubo cervical ligament." While the latter terms do not refer to the parametric tissue, it is stressed as an important support of the bladder as part of the Manchester operation.

All of these operators have performed the Manchester operation extensively and have reported excellent results over a period of many years. From their results, certain deductions might be made. It would seem that the minor or first degree cases of prolapse are cured by mobilization of the bladder and high fixation of the cervix, secured by suturing and shortening the

cardinal ligaments over the anterior surface of the amputated cervix. The more advanced cases or those with a second or third degree prolapse need not only the mobilization of the bladder with suturing of the parametric tissue over the cervix, but also the full exposure of the cardinal ligaments and the placing of these ligaments where they will best serve as a support of the prolapsed uterus.

The Bissell¹⁴ approach to the cardinal ligaments not only exposes these ligaments to their fullest extent, but also mobilizes them so they may be sutured at any given point of the amputated cervix. It would seem that the best support is attained by suturing these ligaments over the amputated surface of the shortened cervix. In this position the maximum amount of uterine support is obtained.

STEPS OF THE OPERATION

First Step. As the cervix is put on the stretch superficial incisions are made to outline the anterior vaginal wall to be resected. A similar superficial circular incision is made at the cervicovaginal junction. With an Allis' clamp placed above and below this circular incision anteriorly, an opening is made through the vaginal wall to the vesicovaginal areolar fascia. Here an artificial pocket is found which forms a natural line of cleavage between the bladder wall and the vaginal wall (Bissell approach).

Second Step. With a gauze-covered finger the bladder wall is separated from the vaginal wall and the vaginal wall is divided in the midline, thus separating the anterior vaginal wall into two lateral halves.

Third Step. The bladder is now separated from its attachments to the cervix and anterior vaginal wall on either side by blunt dissection. This separation is carried up to the junction of the urethra and bladder posteriorly to the level of the uterovesical fold.

Fourth Step. Two Allis' clamps are placed laterally on either side of the

cervicovaginal junction, one above the other. An incision is made between them with the scissors and carried down to the areolar fascia (Bissell approach).¹⁴ Here a pocket is found which may be enlarged by passing the scissors under the cardinal ligaments.

Fifth Step. The cardinal ligaments are ligated at their lower cervical attachments and separated from the cervix high enough to allow for the amputation of the cervix. The cervix is then amputated, enough being removed to leave a uterine cavity three inches in length.

The ligated cardinal ligaments are sutured on either side to the amputated surface of the cervix and also to one another over the anterior surface of the cervix. These sutures should be made to include the cervical tissue.

Sixth Step. The cervical canal is then dilated and the uterus curetted at this point.

Seventh Step. A modified Sturmdorf suture is placed posteriorly to invert the vaginal mucous membrane, and successive sutures are placed alternately on either side carrying the vaginal mucous membrane against the cervix. These sutures, when tied, force the cervix upward and backward. Any redundant vaginal mucous membrane may be cut off at this point. The last suture to be placed is an anterior vaginal inverting suture.

Eighth Step. The vaginal mucous membrane is then sutured beginning at the apex. The lower sutures are made to include the cervical tissue under the bladder. Perineorrhaphy completes the operation.

There is little doubt that the Manchester operation fits a needed place in gynecologic surgery and that it occupies a decided place in any stage of uterine prolapse.

CONCLUSIONS

Gauging the degree of uterine prolapse is important.

The securing of the cardinal ligaments is the essential feature of the Manchester operation.

The minor degrees of uterine prolapse are cured by mobilization of the bladder and the securing and suturing of the parametrial tissue over the anterior surface of the amputated cervix.

The more advanced cases are perhaps better treated by placing the cardinal ligaments over the amputated surface of the shortened cervix. The approach of these ligaments is made without difficulty by means of the Bissell technic.

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ACUTE SURGICAL COMPLICATIONS OF FRACTURES*

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IN the severely injured patient with single or multiple fractures the responsibility often lies heavily on the physician promptly to recognize any associated complications. Survival of the patient may depend largely on the early treatment of these complications before attempting to treat the fracture. Ordinarily a fracture in itself is not sufficient to produce surgical shock, except when the patient has been transported a long distance without proper immobilization.

Such catastrophes as pulmonary clot and fat emboli must always be considered. Clot embolus may occur within the first few hours. Clinically two types of clot emboli occur, namely, a massive embolus with instantaneous death and, secondly, a succession of smaller emboli with death occurring from one to several hours later. While little can be done to avert disaster in the former, evidence is accumulating that in the patient with an initial nonfatal pulmonary embolus intravenous heparin may help. Murray and his co-workers at the University of Toronto have recently heparinized five patients with initial nonfatal pulmonary emboli. Four patients survived with no further emboli manifestations.³ The object is to prolong the blood clotting from two to three times its normal level and to maintain it so for several days. These workers believe that further clot formation at the thrombus site is thus prevented, the possibility of further emboli breaking off from the thrombus lessened and the patient's chance of survival thereby increased. Heparin is still expensive, but it is becoming increasingly available for clinical use.

Other injuries besides the fracture should

be searched for in every case. By other injuries is meant not only other fractures but more serious injuries such as those involving the thorax, abdominal and pelvic organs and brain. The commonest acute injuries to the chest that may complicate a fracture are: injury to the underlying pleura and lung causing pneumothorax, hemothorax, subcutaneous emphysema, traumatic asphyxia, injury to the heart and diaphragm, and more rarely empyema and lung abscess in later stages. An apparently simple fracture or fractures of the ribs may give rise to a host of complications.

Injury to the regional soft tissues of the chest wall may result in rupture of an intercostal artery, producing extensive subcutaneous hemorrhage and a tense painful hematoma. This as a rule will respond slowly to hot poultices and will absorb without further intervention. Evacuation of the clot will rarely be required and is to be withheld to avoid infection. Hemothorax will rarely result, for this almost always results from torn lung tissue.

Injury to the underlying pleura and lung occurs not infrequently in the patient with a fractured rib or ribs. Sudden pneumothorax may occur with dyspnea, moderate cyanosis, cough and acute fear of asphyxia. Clinically there will be marked suppression of breath sounds on the affected side, and x-ray examination will confirm the diagnosis. Pneumothorax is treated by fixation of the chest wall on the affected side with adhesive strapping, followed by aspiration of air from the pleural cavity if the distress is acute.

Laceration of the lung parenchyma from a fractured rib is readily diagnosed if the patient coughs up bloody sputum. Actu-

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ally, however, hemoptysis is not very common. A more certain sign is the stethoscopic evidence of fluid in the smaller air bleeding arouse suspicion of a bleeding intercostal artery. Then, too, operation is indicated to reduce or resect a fragment of

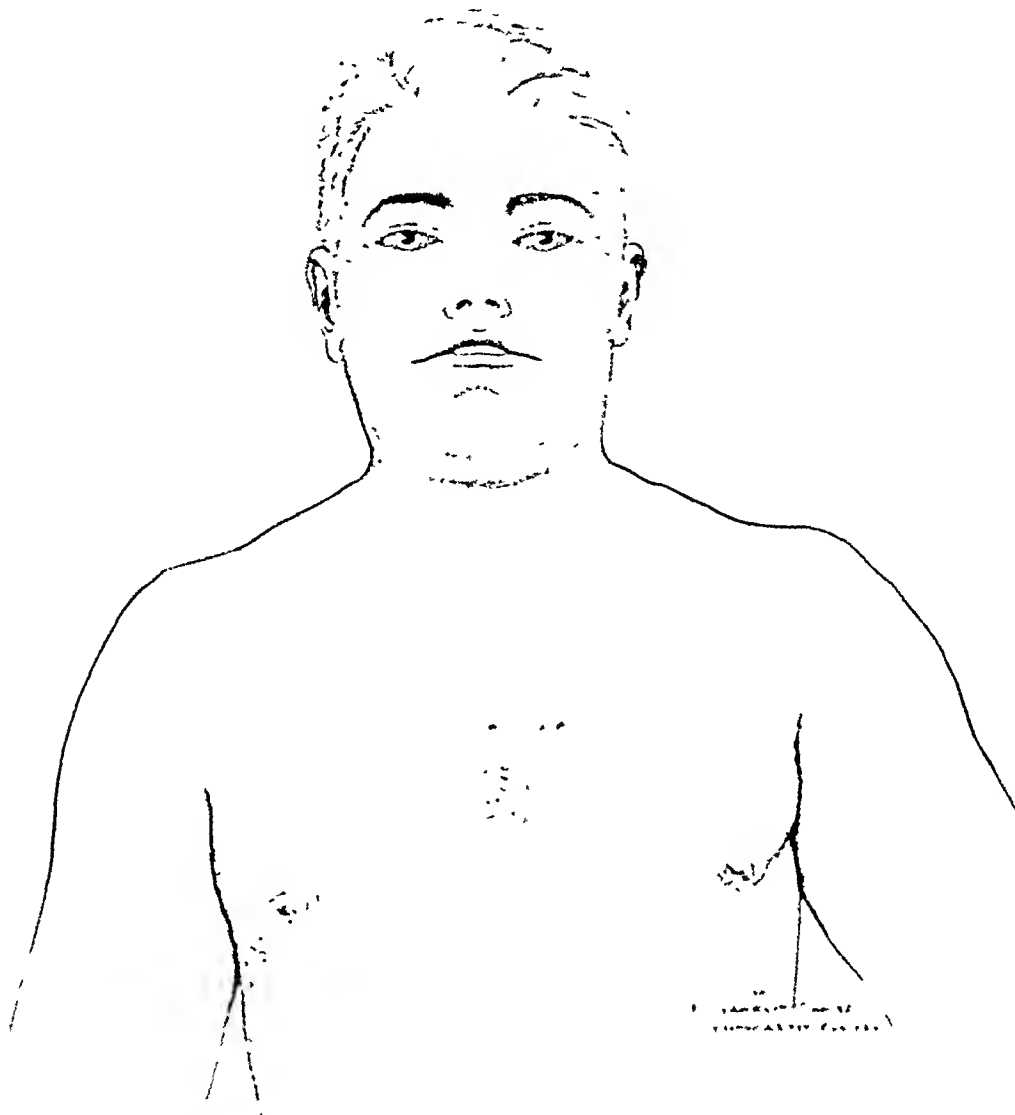


FIG. 1. Traumatic asphyxia. Distribution of venous discoloration following severe crushing injury of chest. Anterior view. (From Green, T. M. Traumatic asphyxia. *Surg., Gynec. & Obst.*, 35: 129-131, 1922.)

passages. If one waits for the coughing up of blood, many cases will be missed. Hemothorax is nearly always evidence of a torn lung. The bleeding usually comes from the vessels of the lung rather than those of the chest wall. Hemothorax should be treated by aspiration of the blood only if embarrassment of heart action occurs, and then only enough blood should be withdrawn to relieve the embarrassment. The blood does not clot in the chest, hence it can always be aspirated if necessary for the comfort of the patient. Operation is indicated only if signs of internal hemorrhage and continued

rib lodged in the lung. The primary shock should be first treated with morphine, parenteral fluids and transfusion as required. Bilateral hemothorax is a very serious complication requiring aspiration often enough and of sufficient amount to relieve the acute embarrassment. This should be supplemented by transfusions to maintain the patient's strength.

Subcutaneous emphysema of varying extent may follow injury to the lungs and pleura. If the rupture of the lung tissue is close to the root of the lung, air may pass along the peritracheal tissue layers up the

mediastinum to the subcutaneous tissues of the neck. If the rupture of the lung parenchyma is more peripheral, with or without rupture of the pleura and pneumo-

have been recommended in the extensive cases where there is painful tension of the tissues, especially with respiratory embarrassment of alarming degree.

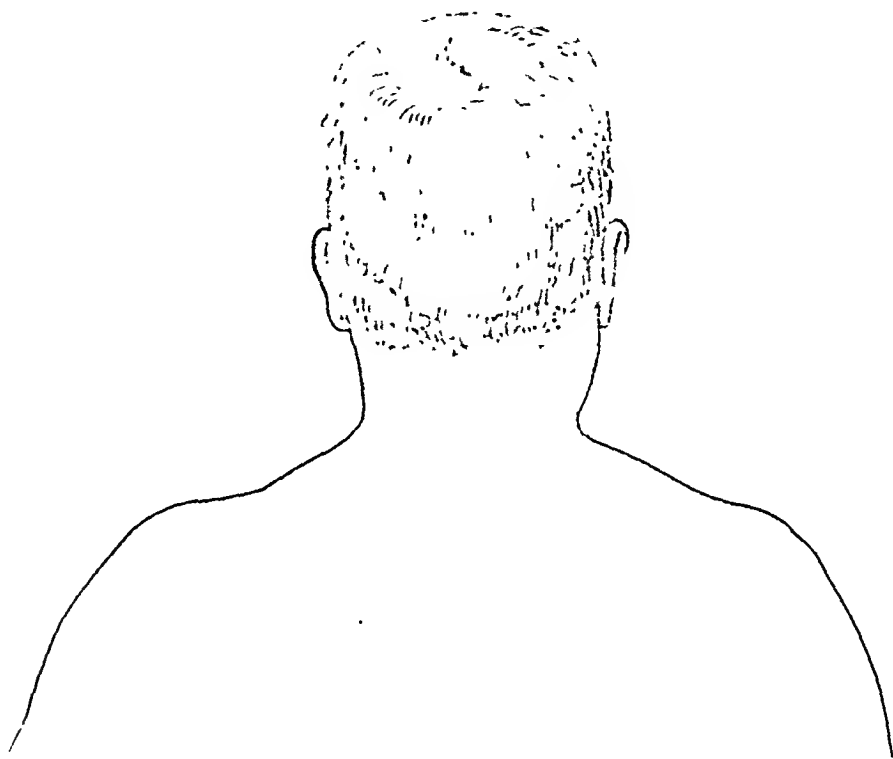


FIG. 2. Posterior distribution of marked discoloration and venous engorgement in traumatic asphyxia. (From Green, T. M. Traumatic asphyxia. *Surg., Gynec. & Obst.*, 35: 120-131, 1922.)

thorax, air may dissect along the smaller bronchi to the root of the lung, thence to the mediastinum and neck. Occasionally, the subcutaneous air spreads rapidly and the neck may swell so as to embarrass respiration severely. It may extend over the whole chest, neck and face, and even over most of the body. While the air easily absorbs without the necessity of intervention, and the complication is not regarded as serious if the skin is unbroken, it may be stated that if air spreads over the entire body a fatal termination is almost certain.²⁶ The emphysema usually disappears in ten days. Treatment consists of firmly strapping the chest to immobilize the affected lung and to prevent further outpouring of air from the lungs into the tissues. Multiple incisions puncturing the subcutaneous tissues in several areas to allow escape of air

Traumatic asphyxia occurs with sufficient frequency to require recognition of its characteristic features. The clinical picture is striking. Green¹³ and Heuer¹⁵ have described the condition in detail with case presentation. (Figs. 1 and 2.) The patient has usually been subjected to violent compression of the thorax and upper abdomen for a few seconds to ten minutes. Rib fractures may or may not be present. Characteristic deep red, blue-black or violet discoloration of the skin of the face, head, neck, and shoulders, front and back, occurs, with a sharp line of demarcation of the shoulder level. (Fig. 1.) Petechiae of the skin and especially of the conjunctivae may be found. Blindness may result. Edema of the face, lips and eyelids also has occurred. The color begins to fade in two to four days and is completely gone in two weeks.

The discoloration is due to marked venous stasis. It is not due to subcutaneous extravasation of blood into the tissues. The veins of the head and neck have no valves. Hence the tremendous back pressure caused by the crushing chest injury is transmitted to the veins of the head and neck, with dilatation and paralysis of the venules and capillaries. The most effective treatment in addition to bed rest is early venesection, thereby correcting any remaining increased venous pressure. The eye grounds should be examined for retinal hemorrhages, for blindness is the most tragic sequel in the surviving patient.

Empyema and lung abscess are late rather than early acute complications of chest injuries. Head¹⁴ reported five cases of serious pleuropulmonary complications following a free interval after injury to the thorax. Three patients developed pyopneumothorax one, three and one-half, and five weeks, respectively, after a blow to the chest. The fourth patient developed empyema two weeks after injury, and the fifth developed a massive hemothorax six weeks after injury.

Injury to the heart and pericardium occurs usually in the most serious cases with rapid fatal outcome. Concussio cordis is a complication causing a very weak, rapid pulse for weeks after the normal convalescent period.

A rent in the diaphragm is very easily sutured from the pleural side but may be extremely difficult from the abdominal aspect. Again, if there is a tear in the stomach in the vicinity of the esophageal opening, the task of the operator is a formidable one: first, to find the opening if small, and second, to make a satisfactory closure.

With a fractured rib it is fairly common to find rigidity of the upper abdominal muscles on the affected side due to irritation of the intercostal nerves. Gentle palpation from the lower abdomen upward will usually reveal relaxation of the muscles at the height of inspiration, and deep abdominal tenderness will be absent. This rigidity

subsides with appropriate strapping of the chest and should have largely disappeared within twenty-four hours. Abdominal distention and varying degrees of adynamic paralytic ileus may also be present. This is apparently reflex in origin and is directly related to the initial trauma. It must be carefully differentiated from perforative and hemorrhagic lesions within the abdomen by reason of its less severe constitutional reaction. Enemas and warm poultices to the abdomen may fail to relieve the distention. The condition as a rule responds promptly, however, to an inlying gastroduodenal catheter with constant suction attached.

INJURIES TO THE ABDOMEN

Hematoma of the abdominal wall because of its rarity may be treated under a doubtful or mistaken diagnosis. It usually results from rupture of the internal mammary or epigastric arteries within the rectus sheath. It should be recognized by its localized soreness and painful tenseness, with or without ecchymosis, plus the lack of severe constitutional symptoms. Often early operation will prevent extensive extravasation of blood into the muscle and subsequent pressure necrosis, infection and abscess formation.²⁰

Signs of severe internal abdominal injuries resulting from a ruptured viscus, spleen or liver, with widespread peritonitis or hemorrhage or both, are usually marked. They demand immediate control of the existing shock and operation without delay. On the other hand it must be emphasized that serious intra-abdominal injuries may exist with few constitutional signs at first. If the bowel be torn by stretching, with immediate spilling of only a small amount of intestinal contents, the patient may for several hours present no symptoms or signs which are in the least alarming. He may even refuse operation for the first twelve hours. The one valuable sign is localized deep tenderness, abdominally or rectally, which cannot be explained by an injury to the abdominal wall. In addition, the ab-

sence of liver dulness on percussion, plus x-ray evidence of air beneath the diaphragm will help to disclose the perforation early.

Moynihan (quoted by Cooke)⁸ believed that laparotomy was justified in all cases in which a rupture of the intestines was suspected, provided vomiting continues after a period of shock and the pulse rate continues to increase. He advised not waiting for an absolutely definite diagnosis. Sudden bursting rupture will produce much the same picture as an acutely perforated ulcer. The unmistakable signs of abdominal rigidity, spasm, pain, and prostration with weak rapid pulse and low blood pressure become obvious immediately. Success will be in direct proportion to the promptness of the intervention. If severe intra-abdominal or retroperitoneal hemorrhage is also present excessive pallor, air hunger, thirst, rapid pulse and low blood pressure will be marked. If adequate fluids and transfusion fail to decrease the pulse rate and restore the blood pressure, immediate operation to control the hemorrhage is imperative. Normal blood does not cause much irritation of the peritoneum and, therefore, will not produce real rigidity. It results in a feeling of abdominal resistance only.

For control of the ruptured bowel the most suitable conservative measures should be employed. These usually comprise simple closure of the perforation with drainage of the infected area, in some instances, simple exteriorization of the lacerated bowel segment according to the method of Mikulicz plus enterostomy for decompression in certain cases. Bowel resection in these seriously handicapped patients should be strenuously avoided wherever possible.

Postoperatively the patient should be placed immediately on constant gastroduodenal suction drainage for several days to decompress the small bowel and combat ileus. High Fowler's position as soon as possible, depending on the severity of the shock, plus adequate morphine to put the intestines at rest, are of course indispensa-

ble to proper management. Repeated rectal examination for possible pelvic abscess should be done with drainage from below when fluctuation occurs.

Finally, experience has shown that tears in the intestine occur most commonly near a fixed point of the bowel, i.e., the second part of the duodenum, the duodenojejunal juncture, ileocecal juncture, and less commonly at the junction of the transverse colon with the ascending and descending colons.

INJURIES OF THE SPLEEN

Crushing injuries to the abdomen, especially bad jolts causing a whipping action to the splenic pedicle, may readily cause rupture of the spleen. This soft, vascular organ has no protective capsule. Its protection by the ribs and diaphragm is more apparent than real. Often very slight trauma will cause great damage. It may be injured by a fractured rib. Pieces of spleen may break off and lie loose in the abdominal cavity. Small lacerations may bleed considerably at first, with formation of a large peritoneal clot that usually causes symptoms as it disintegrates.

The chief symptoms and signs in the patient with a ruptured spleen are those of shock and hemorrhage. The history of the accident, namely, injury to the upper abdomen and left flank, is very important. All patients complain of abdominal pain, at times generalized, but mostly in the left upper quadrant. Abdominal rigidity and distention are common. Dullness in the left iliac fossa may be present. The pulse rate is increased and a falling red blood cell count and hemoglobin are noted on frequently repeated examinations. Other symptoms such as pain in the left shoulder and vomiting are often incidental. The patient may present the picture of an acute surgical abdomen. However, in a suspected case repeated, frequent blood counts plus the clinical signs of progressive blood loss will settle the diagnosis.

Early operation is imperative in the presence of signs of continued severe bleed-

ing. Operation on a badly shocked patient may prove fatal if poorly timed. Consequently, a short time may be justified to prepare the patient by attempting to control the shock with morphine, transfusions, before and after operation if necessary, plus constant intravenous infusion of five per cent dextrose in normal saline and in sterile distilled water. This is kept running before, during and after operation by inserting a needle or Hendon trochar in an anterior superficial ankle vein over the internal malleolus at the level of the ankle.

An attempt to suture or pack tears or lacerations of the spleen wastes time and accomplishes little. Both may be followed by secondary hemorrhage. Removal of the spleen is indicated to control the hemorrhage. No apparent physiologic disturbances result and the patient, if he survives, makes a complete recovery. At operation, if more room is required, for the spleen lies very high and posterior under the left vault of the diaphragm, the costal cartilages of the sixth, seventh and eighth ribs may be divided according to the method of Clute and Albright.⁶

Secondary splenic hemorrhages have been reported in many patients with an abdominal injury treated without operation. Robertson²² believes this has been due to the patient's return to heavy work shortly after supposed recovery from the abdominal injury. Prolonged rest with gradual resumption of work may often avert such accidents.

INJURIES TO THE LIVER

It is common for all lacerations of the liver, tiny and great, loosely to be termed "rupture of the liver." Actual rupture of the liver, in the experience of most observers, is often very rapidly fatal before the shocked patient can be gotten to the operating room. This rapid outcome is due not only to the sudden great intra-abdominal hemorrhage and shock, but also to the associated abdominal injuries from a blow terrific enough to rupture the liver. In most cases reported rupture of the liver has been

accompanied by compound fractures, head injuries and chest crushes. Smaller lacerations of the liver, however, resulting from piercing by a fractured rib or less severe blunt or crushing trauma, bleed profusely during the first twelve hours, after which the bleeding may stop (Robertson). Open wounds of the liver resulting from penetration of sharp objects as a rule demand immediate surgery, and are attended often by good results if the liver laceration is small.

The diagnosis of liver injury cannot always be made with certainty. If there are symptoms of internal hemorrhage, plus localized tenderness and rigidity in the right upper quadrant of the abdomen, a provisional diagnosis can be made. Mild jaundice and bile in the urine develop after most liver injuries, even if slight. Injury to the biliary system most commonly takes the form of tear or rupture of the gallbladder with bile peritonitis.

The chief task of the surgeon in the case of liver injury is to become master of the hemorrhage. The most varied methods have been proposed. If at operation a small laceration is found, any attempt to suture will cause further bleeding. Hence it may be better to leave the laceration along and place a gauze or omental pack against it. Larger rents must be closed by careful mattress suturing, if possible. It is always best to accomplish this by simple suturing plus a gauze tampon, and resort to the many artificial methods if the hemorrhage is thus not controlled. Round blunt needles, with coarse catgut (ribbon catgut if available), silk, fascia strips and narrow gauze tape have been used with success. Because of cutting through the liver substance it is best to start the sutures 1 to 2 cm. from the edges and use a side-to-side maneuvering of the needle, termed "wriggling" by Moynihan, to avoid piercing the blood vessels. If hemorrhage cannot be controlled by ligature, suture gauze packing, thinly impregnated with gelatin, albolene or lubricating jelly is most commonly resorted to, and often arrests the hemorrhage per-

manently. The tampon should be firmly packed in the wound as in packing the uterine cavity. As it loosens it should be gradually removed from the third day on to avoid a biliary fistula.

While suturing and gauze tampon are most often used, much has been done to increase the resources of the surgeon in controlling liver hemorrhage. Digital compression of the portal vein and hepatic artery with the finger in the foramen of Winslow will arrest the liver hemorrhage during suture.^{19,21} McDill has passed a rubber covered intestinal clamp through a second incision one inch in length, placed laterally in the right upper quadrant, to compress the portal vein and hepatic artery for short periods during surgery of the liver.

Using the omentum as a pack or tampon has proved repeatedly successful.^{3,12,14,26} A generous portion of the omentum is ligated and cut away. As an isolated graft it is placed in the liver wound. It is held in place by suturing along the liver edges or by placing a gauze pack against it. Those who have used this method have found that it promptly arrests hemorrhage, becomes adherent to the liver bed in twelve hours, and prevents secondary hemorrhage.^{1,2,3,26} It also helps in preventing the cutting through of sutures in the liver tissue.

Other methods, namely, masselastic ligature, decalcified whalebone and absorbable magnesium plates for compression of the liver laceration and to prevent cutting through of sutures have proved useful, but they are less readily available in the usual emergency situation. The thermocautery is only occasionally effective and it increases the danger of secondary hemorrhage from sloughing of the coagulated liver tissue.

INJURIES TO THE PANCREAS

Damage to the pancreas usually occurs as either a mild contusion to the gland or as the more severe form of acute hemorrhagic pancreatitis. Mild contusion is fairly common, as evidenced by glycosuria during

convalescence from an abdominal injury, and it causes no symptoms of acute pancreatitis. Painless blood cysts may later develop. Associated abdominal injuries are almost always present to complicate the picture. The more severe injury causes characteristic symptoms resulting from hemorrhage and leakage of pancreatic enzymes to cause fat necrosis. The epigastric and lumbar back pain may be agonizing and it is not relieved by the ordinary dose of morphine. It persists either intermittently or steadily until relieved by operation. Collapse may be profound. The patient usually lies motionless afraid to move. The abdomen is rarely rigid or board-like. Epigastric tenderness slightly to the left of the midline is a more constant finding. Vomiting occurs only if peritoneal irritation is present and then it is persistent despite gastric drainage.

Laboratory tests to date have not proved a reliable aid in diagnosis. The determination of diastase in the urine may prove helpful,¹⁷ but the diagnosis must be made largely from the clinical findings.

On any evidence of hemorrhagic pancreatitis early operation to control the hemorrhage and fat necrosis has been advocated.²² At operation, through a right rectus incision the gastrocolic omentum is traversed through an avascular area and the lesser peritoneal cavity is thus exposed. Septic material should be drained. Severe bleeding may be controlled by deep suture. Tamponage is usually effective and safest. Pancreatic fistula will probably develop if the overlying peritoneum or gland tissue is incised or ruptured. The fistula will drain for a prolonged period, usually despite all measures to control it and many will gradually heal spontaneously.

With less evidence than that of hemorrhagic pancreatitis conservative measures may be tried, namely, parenteral fluids, inlying nasal tube for aspiration and lavage, sedation by the barbiturates and avoidance of morphine because of its constricting effect on the sphincter of Oddi. Magnesium sulphate (12 cc. of 50 per cent

solution three times daily) may be given through the nasal tube to facilitate drainage of bile into the duodenum (Lium). Prolonged bed rest, high fat diet and no heavy work for at least two months should be advised. The urine and blood should be watched for sugar. This gradually disappears in the majority of cases and does not recur.

Rupture of the portal vein, of the abdominal aorta and injury to the pancreas by dislocated vertebra result in quick fatality and occasion no further comment here. Laceration of the omentum and mesentery should be mentioned as less common causes of intra-abdominal hemorrhage.

INJURIES TO THE KIDNEYS

A blow to the flank, tearing by a fractured rib, with no evidence of external trauma, may cause damage to the kidney, varying from a tiny tear to complete laceration. From the clinical signs one can deduce fairly well the probable extent of the injury. Flank pain and slight tenderness, plus hematuria are the most common findings. These indicate contusion alone or small laceration of the kidney with moderate retroperitoneal hematoma.

If the injury to the kidney is severe, all the symptoms of shock will be superimposed, due chiefly to retroperitoneal hemorrhage. If a tear through the posterior peritoneum occurs, the signs will be more acute due to increased hemorrhage and peritoneal irritation. In most cases with or without rupture of the peritoneum there will be definite signs of early peritonitis, i.e., abdominal tenderness with muscle spasm on the affected side, plus nausea, vomiting and leukocytosis. These abdominal signs are due to irritation of the abdominothoracic nerves by the retroperitoneal hemorrhage. They are not due to extravasation of urine, which has been shown rarely to occur in significant amount to increase the early symptoms. However, it does increase the possibility of later infection.⁷

In the absence of severe manifestations active intervention may be delayed. Prolonged bed rest, even though hematuria is considerable, will usually suffice. The reparative ability of the kidney is great, if the injury is not too severe and if rupture of the peritoneum has not occurred.

If hematuria and signs of peritoneal irritation and shock are marked, early operation should be carried out to control the hemorrhage and prevent serious peritoneal extravasation. The anterior abdominal approach has often been found advisable, especially to control any associated abdominal injuries that may be present. Simple lacerations of the kidney may be closed with interrupted sutures. The severely injured kidney should be removed, however. Drainage through the flank should be instituted to control sepsis. Failure to operate on these patients with severe injury to the kidney may result in a fatal outcome, due to uncontrolled hemorrhage, perinephric abscess and peritonitis. Thus the decision to operate depends on the clinical evidence as to the extent of kidney damage.

INJURY TO THE PELVIC VISCERA

Fractures of the pelvis are occasioned by great violence. The danger lies in the extent of complicating visceral injuries. Rupture or tear of the urethra is more common than of the bladder. Rupture of the bowel, though less common, does occur, especially with fracture of the ilium.

Symptoms and signs of the complications are interpreted by the abdominal, urinary, vaginal and rectal findings. In all patients with a fractured pelvis, bladder and urethral injury should be determined at once. It is wise to have the patient urinate as soon as he is seen. If he is unable to urinate, a catheter should be used to determine the condition of the urethra and bladder. If a small amount of bloody fluid is obtained before the bladder is reached, the urethra is torn or lacerated. If the urine obtained is bloody and in small amounts, rupture of the bladder is suspected. Under no condi-

tions is it wise to introduce a measured amount of sterile fluid to ascertain what proportions can be returned by catheter.²³ Not only may false information be obtained but increased danger of peritonitis from the rupture of the bladder may follow.

The urethra is torn usually through its membranous portion. An actual fragment of bone perforating the urethra is extremely rare. Any bony displacement of the pubic rami, however, means a tear through the urethra, for the jar to the pubic arch is transmitted through the inelastic triangular ligament. From a rupture of the bulbous portion of the urethra, distal to the triangular ligament, blood and urine may extravasate in the perineal and scrotal tissues in twelve to eighteen hours. Extravasation of blood and urine into the groins and pubic regions indicates extraperitoneal rupture of the bladder or urethral rupture proximal to the triangular ligament. Rapidly increasing lower abdominal tenderness plus dullness in the flanks of the lower abdomen within twelve hours after the injury indicates intraperitoneal rupture of the bladder and peritonitis. Hemorrhage will produce greater shock and rapid development of free fluid in the abdomen.

When bladder or urethral rupture is seriously suspected operation should be done at once. Less than 1 per cent of bladder ruptures recover spontaneously.²⁵ Urethral rupture and perineal extravasation should be freely drained through a perineal incision. The bladder should be drained by passing a catheter through the proximal urethral opening if it can be found, or by free incision into the bladder. It is not often possible to effect primary suture of the torn urethra. This should be done at a later date after recovery. For rupture of the urethra suprapubic drainage is usually not indicated.

Free fluid, shock and lack of urine indicate early suprapubic operation. Primary suture of the bladder laceration should be carried out, followed by drainage of the peritoneal cavity if opened and of the space of Rhetzius. Bladder drainage by a catheter

in the urethra will keep the bladder empty and avoid pressure of the suture line. Suprapubic cystotomy drainage in the presence of fractured pelvis may lead to infection of the hematoma about the fracture with resultant osteomyelitis.

The likelihood of rupture of the bowel, especially in crushing injuries to the false pelvis and ilium has been stressed in great detail by Wilson. The abdominal signs of perforation and peritonitis, as hitherto described, should be recognized early and immediate control by operation carried out.

SUMMARY

The need for early recognition of associated injuries to the soft parts in the patient with fractures has prompted this effort. The essential features of the more common and serious complications have been stressed. Attention has been given in some detail to associated injuries of the head, thoracic, abdominal and pelvic viscera and their management.

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CORRECTIONS

Due credit should have been given to Underwood and Underwood, photographers, for the excellent picture of Dr. Welton which appeared in our January issue on page eight.

* * *

On page XII in our January issue, the name of the founder of the J. Sklar Manufacturing Company was given as Ohn Sklar beneath the inset. This should have read John Sklar.

NATURAL ADRENAL CORTEX EXTRACT AND COAGULATION OF BLOOD

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MY attention was first drawn to the possibility that the secretion from the cortex of the adrenal gland might have some relationship to coagulation of blood, during the early months of 1936. At that time, while studying the effects of this secretion in the prevention and treatment of surgical shock, I noticed what appeared to be abnormally rapid formation of clots in the field of operation. I found that where previously I had been removing liquid blood on the sponges, clot formation was now present. Accordingly, a series of studies was started with surgical cases, in which the adrenal cortex extract was being given to fortify the patient against shock, in order to determine if this potent extract had any real effect on the clotting time of the blood. Careful search of all of the available literature failed to show any mention of such a possibility. The first thought was really quite adverse to all of the teachings regarding coagulating processes, inasmuch as I was working with an extract made up of lipoidal bodies in solution. In all of the literature no mention was made of any lipoidal substance as effecting coagulation favorably or entering into the phenomenon of coagulation. From the known effects of anesthetic agents, it was to be expected, that they of themselves would naturally lengthen the time of coagulation. The effects of anesthetic agents on the coagulation of blood have been very well covered in the literature. This may well be summed up by the statement that saturation of the blood stream with any of the anesthetic agents lengthens coagulation time.

The shock of surgery is known to have an adverse effect on coagulation time. Again

this did not correlate with the fact that here there appeared to be an abnormally fast clotting time. The shock to which all surgical patients are submitted is of three types; and it is the sum total of all these types to which all surgical patients are submitted which we class as surgical shock: (1) Psychic shocks, or that induced by fear which all patients have of impending surgery. (2) Anesthetic shock, or that induced, by the administration of any anesthetic agent into the blood stream. All such agents are foreign substances and not found in normal circulating blood. (3) Actual shock incident to surgery, from traumatism to tissues due to necessary handling and cutting. This of course each surgeon tries to hold to the minimum by careful, skillful work according to his own personal ability.

Psychic shock can be reduced to a minimum by properly indicated medication and mental preparation before the patient is taken to the operating room. This of course will be varied to meet the individual needs of each and every patient. Anesthetic shock should be reduced to the minimum by the selection of an anesthetic agent to meet the needs of the individual patient and the type and extent of the surgery contemplated. Anesthetic shock may be further reduced by the skillful administration of the anesthetic by a well trained anesthetist. The amount of shock due to tissue traumatism must of necessity vary with each individual case, according to the specific conditions arising during the operation. Adhesions and other factors may or may not be present, which of course will slow the operation and demand a more extensive dissection. The extent and magnitude of

the operation again is a large factor in the amount of shock produced. For example, it is common information that a hysterectomy or cholecystectomy is productive of greater shock than an ordinary appendectomy. One other possible factor enters into the amount of traumatic shock produced and that is the individual skill and touch of the operator. One operator will have a pair of light dextrous hands, skillful to the highest degree, and another, while his hands are equally skillful will have a heavy touch and be very rough in his handling of tissues. In his recent book entitled "Shock," Doctor Scudder¹ has brought out the fact that serum potassium is elevated during shock, and that this increase is proportionate to the severity of the shocked condition of the patient. From this brief outline of known facts, it becomes evident that coagulation time is longer as may be expected during the time of surgery due to the varying degree of shock sustained by each patient. This lengthening of coagulation time, of course, will vary according to the normal coagulation time of the individual patient and his biochemical response to the amount of shock induced by surgery.

Through the cooperation of the interne and laboratory staffs of Highland Park General Hospital, I was able to have coagulation times taken on all of my surgical patients on entrance to the hospital. These records were taken again following the administration of the adrenal cortex extract which was given as a routine part of the preoperative preparation of the patient. Careful studies were made of the data thus obtained. The result of this study was the demonstration of a definite lowering of coagulation time following the parenteral administration of the adrenal cortex extract. Up to and including the present time I have followed this work through a series of well over 200 cases. During this series, I have found but one case in which there was not an actual lowering of the coagulation time following the administration of the extract. The information on that case appears as number 50 in Table 1.

This table shows the operative diagnosis of each case, except in the case of pregnancy which required cesarean section. These have been listed as cesarean sections and the cause for which the sections were done is given. The coagulation time before and after the administration of the cortical extract is given in minutes and fractions thereof. The time of surgery, after the administration of the cortical extract was in all instances between one and three hours. The extract was given so that the effects would attain full activity one hour after administration. From Table 11 it will be seen that these effects last for several hours, but are at their peak during the second and third hours following administration. Surgery is timed so as to come during this period of maximum effect. From Table 1 it can be seen that there was a net drop of 29.44 per cent in the time of coagulation, average for all of the fifty cases reported. These cases are taken from a general run of surgery and include a wide variety of acute and chronic conditions.

Case No. 50 is the only one which does not show a favorably changed coagulation time. This was a case of multiple leiomyofibromas of the uterus, which had been under medical treatment for over two years. There had been a progressive loss of blood, during that time, with the result that a well developed secondary anemia was present when the patient was first seen. Her total red cell count was under three million, and the hemoglobin was under 50 per cent. Serum calcium and protein determinations were not made on this case as they were not thought to be necessary to the treatment of her condition. I afterward regretted this lack of more complete laboratory data, for I am of the opinion that much might have been learned from the case had these data been obtained. For these reasons a satisfactory answer as to what might or might not have been the reason for a failure of the reaction in this one case is impossible. It would be reasonable to suppose that both the serum calcium and prothrombin factors might

TABLE I

COAGULATION TIMES OF SURGICAL PATIENTS BEFORE AND AFTER THE ADMINISTRATION OF ADRENAL CORTEX EXTRACT

Name	Sex	Diagnosis	Coagulation Time Minutes		Percent-age Decrease
			Before	After	
1. M. B	F	Chronic appendicitis, chronic salpingitis, cystic right ovary	4½	4	11
2. M. P	F	Chronic cholecystitis	6½	3	53.3
3. E. R	M	Chronic appendicitis	5½	4	27.2
4. M. S	F	Cesarean section; maternal dystocia	4	2½	37.5
5. C. G	F	Pyosalpingitis	5½	4½	27.2
6. D. C	F	Acute appendicitis	4½	4	11.1
7. C. H	F	Thyroid adenoma	6	5	16.6
8. D. W	F	Chronic salpingitis	5½	5	9.0
9. J. S	F	Ruptured ectopic pregnancy	5	4	20.0
10. W. K	F	Pyosalpingitis	7½	3½	53.0
11. D. H	F	Thyroid adenoma	6½	3½	46.0
12. N. N	F	Multiple degenerative fibromas of uterus	6	3½	41.6
13. E. K	F	Chronic appendicitis	4	3	25.0
14. M. McF	F	Multiple cysts, right ovary; adhesions	5½	4½	18.0
15. F. C	F	Multiple fibroids of uterus	6½	5½	15.3
16. J. W	F	Fibroids of uterus	6	4	33.3
17. W. H	M	Multiple hemorrhoids; rectal fistula	5½	4	27.2
18. S. C	F	Pyosalpingitis	6½	5	23.0
19. C. W	F	Chronic appendicitis	3½	2½	28.5
20. J. R	F	Pan-hysterectomy, following radium for early cancer of cervix	7	6	14.2
21. H. B	M	Acute appendicitis	7½	5	33.3
22. M. H	F	Urachal cyst	7½	5	33.3
23. J. D	M	Acute appendicitis	4	3½	12.5
24. A. R	F	Multiple fibroids of uterus	6½	5½	15.3
25. G. R	M	Acute appendicitis	7½	5	33.3
26. B. S	F	Thyroid adenoma	5½	3½	36.3
27. M. C	F	Thyroid adenoma	6½	5	23.0
28. D. J	F	Thyroid adenoma	7½	5	33.3
29. L. B	F	Gangrene of gallbladder	5	4½	10.0
30. J. K	M	Fibrosarcoma of neck	6	3½	41.6
31. W. K	F	Fibroid uterus	4½	4	11.1
32. J. P	F	Acute appendicitis	3½	3	14.5
33. M. S	F	Chronic appendicitis	5	3½	27.2
34. L. H	F	Acute appendicitis	5½	4	27.2
35. E. S	F	Chronic cholecystitis	7½	5½	26.6
36. M. T	F	Fibroid uterus	5	3	40.0
37. L. S	F	Fibroid uterus	6½	4	38.6
38. H. B	F	Acute appendicitis	5½	4½	18.1
39. H. H	F	Osteomyelitis; (2nd rib right)	6½	5½	15.3
40. D. H	F	Chronic appendicitis	6½	3	53.8
41. J. B	F	Urachal cyst	6½	4½	30.7
42. M. V	F	Thyroid adenoma	6½	5	23.0
43. J. M	F	Acute appendicitis; pregnant 8 weeks	4½	2½	44.4
44. A. R	F	Ovarian cyst; pregnant 9 weeks	6½	3	53.8
45. D. DeB	F	Acute appendicitis	6	3½	41.0
46. C. S	F	Chronic appendicitis	5	3½	30.0
47. S. H	F	Chronic salpingitis	7½	4	46.6
48. V. D	F	Cesarean section; maternal dystocia	5½	3	45.4
49. H. S	F	Chronic cholecystitis	7½	5	33.3
50. F. S	F	Multiple uterine fibroids	5	5	00.0

Average reduction of coagulation time 29.44 per cent.

have been below normal from constant drainage of the blood stream over such a long period of time. Thus if either one or both of those vital factors were depleted, there was no possible factor with which the cortical extract could react and thus expedite coagulation.

At the suggestion of Doctor Frederick A. Collier I have been studying the effects of adrenal cortex extract regarding coagulation in all liver and gallbladder cases. While at the present time I do not have a sufficient number of cases to give any definite data, the results so far have shown a substantial decrease of coagulation time in all cases of chronic cholecystitis, even when moderate icterus is present. Three cases of chronic cholecystitis appear in the group under Table 1. The reduction of coagulation time in these three cases varies from 26.6 per cent to 53.3 per cent. A study of all cases of this type of chronic cholecystitis would indicate that the reduction in coagulation time for the group is higher than the average for all types of cases as reported in this general surgical group. The cases of acute cholecystitis with active infection or gangrene present did not show as great a reduction of coagulation time as did the chronic cases. Up to and including the present time, I have not found a case of cholecystitis which did not show some reduction with this treatment. I have reported one case in this group of acute gangrenous cholecystitis which shows a reduction of 10 per cent after cortical preparation (Case No. 29—Table 1). It appears from a study of all cases that there is less reduction of coagulation time when acute active infection is present whether in the gallbladder or elsewhere. Thus patients with an acute infection do not show as great a reduction of coagulation time as does the chronic type of case in which there is obviously less toxicity.

During the past several months it has been my practice to give larger amounts of cortical extract in the surgical preparation of the patient with obvious acute infection present. This has aided coagulation favor-

ably and has produced a beneficial effect upon the general condition of the patient, such as better maintenance of blood pressure during the operative and postoperative periods. Those receiving more extract have exhibited less evidence of shock and toxicity. All cases reported in chart #1 received exactly the same amount of cortical extract, regardless of condition. This has been done in order that at least some basis for accurate comparison might be had. The fact that the acutely infected and toxic cases failed to show the same amount of reaction to the treatment, as did the chronic ones with similar dosages of the extract, can be explained by the fact that acute infection always affects liver metabolism or function adversely by the toxic load under which this vital organ is forced to work. With lowered activity of the liver, it is logical to say that there is probably a lower fibrinogen or prothrombin level in the blood of the acutely ill patient. It is also logical to say that there is a lower level of normal cortical secretion in the acutely ill patient with active infection.

During the past two years I have been a frequent attendant at autopsies done by Doctor Casper at Herman Kiefer Hospital in Detroit. These were performed on patients who had died from acute infectious diseases (poliomyelitis and scarlet fever). All of these bodies showed an acute exhaustion of the cortical cells of the adrenal glands. This would indicate that such an exhaustion of the adrenal cortex takes place in any case of acute infection. The fact that the acutely ill patient does respond better to larger amounts of the extract would further bear out this point. As to the specific manner in which adrenal cortex extract affects the coagulation time in these patients, there appear to be two possible explanations: First, that the cortical extract or secretion is an activator of liver cells and thus raises the prothrombin or fibrinogen level. Second, that it may be through activation of the serum calcium that the available prothrombin is more readily activated. In either instance the end

result would be a lowering of coagulation time.

After establishing the fact that a definite reduction of coagulation time was produced by the administration of the extract to the sick patient, a series of tests was run on ten normal individuals. For this purpose ten volunteers were taken, equally divided

Ten minutes after administration of the extract there was no change in any one of the group. At twenty minutes the group showed a reduction of 9.2 per cent of coagulation time. The reduction of time continued progressively, and one hour after the treatment was given the average reduction of time was 34.9 per cent. A maximum

TABLE II

COAGULATION TIMES OF NORMAL INDIVIDUALS, WITH AND WITHOUT FORTIFICATION WITH ADRENAL CORTEX EXTRACT

Name	Sex	Age	Before Admin- istration	After Administration								
				10 Min.	20 Min.	30 Min.	40 Min.	50 Min.	1 Hr.	2 Hr.	3 Hr.	24 Hrs.
R. H..	M	42	5-00	5-00	4-45	4-30	4-30	4-00	3-30	3-30	3-30	4-15
D. H..	M	27	6-00	6-00	5-15	5-15	4-45	4-15	4-00	3-30	3-30	4-30
E. T..	F	21	4-45	4-45	4-45	4-00	4-00	3-45	3-30	3-30	3-30	4-00
V. E..	F	20	5-00	5-00	5-00	4-30	4-15	4-00	3-30	3-00	3-00	4-00
F. P..	M	38	4-30	4-30	4-30	4-00	3-45	3-30	3-00	3-00	3-00	3-45
G. B..	M	39	6-00	6-00	5-30	5-15	4-30	4-15	3-30	3-00	3-30	4-30
P. R..	M	22	4-15	4-15	4-00	3-45	3-30	3-00	2-15	2-15	2-15	3-45
C. L..	F	29	5-30	5-30	5-15	4-30	4-15	3-45	3-15	3-15	3-15	4-15
M. R..	F	40	5-45	5-45	5-15	4-45	4-15	4-00	3-30	3-15	3-15	4-30
E. H..	F	27	4-00	4-00	4-00	3-30	3-15	3-00	3-00	3-00	3-00	3-30
Total of times.....			50-45	50-45	47-45	44-00	41-00	37-30	33-00	31-15	31-45	41-00
Percentage reduction .. .			0%	0%	9.2%	13.3%	19.2%	26.1%	34.9%	38.4%	37.4%	19.2%

between the sexes. These volunteers were given complete physical examinations and found to be free from visible pathology. In other words, the normal was taken as an average adult in good health for the age stated in each instance. The ages ranged from twenty to forty years and represented a fair cross section of adult life. Each individual was administered 1 cc. of adrenal cortex extract intramuscularly. No allowances were made for weight, age or sex, in order that the results might be judged by the size of the dose alone. Coagulation time was taken for each individual prior to the administration of the extract and recorded. Following administration of the extract coagulation times were taken at regular ten minute intervals. The result of this work is given in Table II.

reduction of 38.4 per cent was reached at the two hour period. During the next hour the activity of coagulation began to subside, and at three hours the average showed a net reduction of 37.4 per cent. This would indicate that the reaction is rapid in onset and sustained at a high level during the period from one to three hours after injection of the extract. Upon this finding, I am at present gauging the time of injection of the extract, in preparing my patients for surgery. Thus I am being assured the maximum effect during the period of surgery. Twenty-four hours after treatment had been given coagulation times were recorded. The result of this showed a reduction of 19.2 per cent from the original findings. This would indicate that the effects are not transitory, but last for at least the

twenty-four hour period with an apparent gradual reduction as the body uses the extract. Upon these findings treatments for the postoperative patient are based. The extract is given in doses considered sufficient for the individual patient at regular twelve hour intervals, in order that the patient may have a sufficient amount always present so that there will be no abnormal drain of natural cortical secretion from the adrenal cortex. The intramuscular route is recommended in preference to the intravenous for sustained action, due to the fact that extract given intramuscularly is slowly absorbed and can be used by the body as it is taken from the muscle area. By this means a rapid coagulation of the blood during the postoperative period has been maintained.

Careful search of the available medical literature for the past five years shows that there is nothing recorded as regards the effects of adrenal cortex extracts on coagulation time of blood. Grollman in his comprehensive book, "The Adrenals," makes no mention in regard to this phenomenon.² Mention is made of the fact that small doses of adrenalin when given hypodermically, decrease the time of coagulation. He suggests that this action is due to stimulation of liver cells by the adrenalin, and that through their activity in secreting hormones the biochemistry is changed in manners favorable to rapid coagulation. He further states that large doses of adrenalin have an opposite effect on the coagulation process and retard it. This latter action he makes no attempt to explain. Since there is no available literature on the subject of cortical secretion and its effects on coagulation of blood, I believe this to be an original finding in regard to the action of this extract.

THEORIES OF COAGULATION

A brief résumé of the theories of coagulation is in order at this time, in order that an effort may be made to correlate the finding with existing knowledge and information regarding this subject. Considerable con-

troversy exists at the present time as to the exact biochemical changes and substances producing the phenomena of coagulation. Numerous substances have been cited by various workers, any one of which will hasten or activate the process. Notably among these are cephalin, prothrombin, fibrinogen, heparin, proserozyme and serozyme, of Bordet, and numerous other bodies. Pickering³ teaches that the contact of blood with any surface that it wets, provokes electrical changes in plasma, with disintegration of colloidal complexes from both the platelets and plasma. Material in equilibrium in vivo is thus replaced by bodies susceptible to rapid change, any one of which may under certain circumstances favorably alter coagulation time of blood. He evidently refers to these substances described by the other workers as colloidal substances, and believes that any one, or combinations of various types may under varying circumstances produce or activate coagulation of blood. Calcium ions must of necessity be classed in this group of colloidal substances effecting coagulation in a favorable manner. This effect of calcium salts has been well known for many years.

Pickering³ further teaches that there are at least three modes of development of clotting: (1) Clots or gels are formed from blood in vivo, by the interaction of certain plasma and platelet constituents, without the intervention of any other known body or factor. Such antemortem clots are frequently found at autopsy in the chambers of the heart and elsewhere in the vascular system. In such cases it is impossible to find any evidence of vascular trauma, which might have excited the elaboration of any of the various enzymes or factors from either the plasma or platelets. In clotting of this type, there has been no apparent exposure to air or contact with any substance foreign to blood. The blood has at all times been confined to the vascular system and has been in contact only with the normal endothelial cell lining of this system. Obviously some explanation

for this abnormal type of clotting must come from biochemical changes taking place within the body itself and as yet undiscovered. Fibrous organization of clots of this type is almost always present at autopsy, thus proving that the clotting process took place and had existed for a considerable time antemortem. It is often from clots such as these that emboli may have their origin. (2) Platelets when exposed to the air or striking a substance foreign to the normal endothelial lining of the vascular system disintegrate and liberate cytozyme. Cytozyme flocculates plasma and assists in the lysis of the various plasma complexes, (whatever they may be) with a resultant liberation of prothrombin. Prothrombin reacts with the calcium ions of the blood plasma to form thrombin. Thrombin activates fibrinogen to produce fibrin with a resultant precipitation, and clot formation. (3) Materials liberated from wounded tissues may at times take the place of cytozyme from the platelets and thus become the activating substance in thrombin formation. From the foregoing résumé, one can see that any factor which would influence the formation of any one of the various factors involved in this complex process might effect coagulation in either a favorable manner or otherwise.

Pickering also makes note of one fact, which seems very poignant in view of the late research of Doctor Scudder and Dr. Zwemer.⁴ He states that coagulation time is often reduced by the ingestion of food into the stomach. No attempt is made to explain this phenomenon. A possible explanation of this may be had from the recent works of Dr. Scudder and Dr. Zwemer during which they have studied the blood sera and gastric contents of patients suffering from obstruction of the bowel. In these cases they found that the gastric contents and the blood sera were both abnormally high in potassium. These same workers have shown that a similar hyperpotassium content was present in the serum during shock and was also accompanied by a similar hyperpotassium content

in the gastric contents. Since there is no evidence available at present on this point, the thought suggests itself that possibly there is a serum potassium rise during hunger periods. This would be partially neutralized by the ingestion of food with a subsequent drop in serum potassium, and thus the calcium ions of the blood serum, becoming more active, would reduce the time of coagulation.

A review of the literature dealing with potassium poisoning shows that potassium salts have a definite effect on coagulation time of blood. The effect is to lengthen that time. This is in accordance with the kind of potassium salt taken and the amount. The caustic action of the hydrate or hydroxide is well known for its corrosive action locally on the mucous membranes of the mouth, esophagus and stomach. There is a similar action on the mucous membranes produced by taking strong solutions of the dichromate, chlorate or nitrate. The citrate, acetate and chloride, while not producing the local corrosive action of the other more active salts, are useful as medications but may be taken in sufficient quantities to produce generalized damage to body tissues. In case either group of salts or anyone of them is taken in poisonous doses, a more or less definite course of reaction follows. One of the first effects is hemolysis of red blood cells and a lengthening of coagulation time. This is followed by violent abdominal pains, vomiting, purging, general collapse and eventually death from cardiac paralysis. It is the blood picture which is of interest in this correlation with a lengthening of coagulation time and hemolysis. These two phenomena are the first to appear and the last to disappear in the patient who eventually recovers. One of the chief objective signs of this condition is the small petechial hemorrhage spots on various portions of the body surface which often remain for many days after the patient has recovered. During this time there is a longer than normal coagulation time present.

The facts regarding potassium poisoning coupled with the findings of an increased serum potassium when the gastric content potassium is high, of Dr. Scudder and Dr. Zwemer, would point to the fact which Pickering brings out in regard to the ingestion of food lowering coagulation time, as possibly having a basis in the reduction of the potassium content during the digestion of food. This reduction takes place in both the stomach contents and the blood serum. Doctor Scudder³ has further shown by means of case records in his recent book entitled "Shock," that the injection of adrenal cortical extract intravenously for postoperative shock was effectual in nearly all cases where a hyperpotassemia existed. Thus it was proved that when this important body electrolyte was restored to normal, general bodily functions improved in accordance.

From the foregoing résumé of the theories of coagulation of blood, the toxicology of potassium and the recent work of Dr. Scudder and Dr. Zwemer, it becomes possible to correlate these with the known facts regarding the action of adrenal cortex extracts, and arrive at a possible *modus operandi* of the cortical hormones in favorably effecting the coagulation of blood. Two possible modes of action can be shown and two theories set forth. It is not known whether either one acting alone is responsible for the result, or if both working together produce it. Again there may be some explanation which the author has not conceived, which is responsible. The two possible manners are as follows: First, it may be entirely because of the balancing effect of the adrenal cortical secretion on body electrolytes thus repressing the over amount of potassium and making active the sodium and calcium salts in blood serum. Second, it may be due to the favorable effects of this secretion in stimulating normal activity of liver tissue, thus activating the formation of prothrombin, thrombin and fibrin in that vital tissue. It would be possible to effect the process of coagulation in either manner mentioned,

or by a combination of the two. The exact manner in which this is accomplished is not known and for that reason two theories have been advanced.

It is a conceded fact that the adrenal cortex secretion either supplied in a normal manner, by secretion from the gland into the blood stream or injected into the body as an extract does effect a balance of the body electrolytes. This is accomplished by the activation of the sodium and calcium ions, which are complimentary to each other. The result being a repression of excess potassium ions in the blood serum which are antagonistic to normal sodium and calcium activity. Dr. Scudder has shown that it is possible to produce a hypopotassemia by the intravenous injection of large amounts of the extract.⁵ This the author did not see when the extract was used intramuscularly. From these facts it would seem that this balancing of body electrolytes in favor of sodium and calcium ion activity could effect a reduction in coagulation time. From the study of Pickering's teachings one fact is poignant. Calcium in an active form is necessary for normal coagulation of blood. Thus if the calcium ions are activated in blood serum by the secretion or extract of the adrenal cortex, the cortical secretion would of necessity become a normal part of this vital process of coagulation. For this reason alone, the injection of a potent extract should activate the process.

The second manner in which cortical extract or secretion might enter into the coagulation process and have a favorable influence can be explained by its effects in favorably influencing normal activity of liver cells. Dr. Crile,⁶ in his book, "Diseases Peculiar to Civilized Man," has pointed out the dual venous circulation of the adrenal gland. His analysis of this is that through the adrenal vein coming from the lower pole of the gland, the medulla is able to secrete adrenalin directly into the vena cava as a part of the kinetic gland mechanism of defense or activation of the body for that purpose. The cortical veins all

drain and empty into tributaries of the portal vein, thus the normal secretion must pass through the liver before it can reach the general circulation. During the past four years it has been noted that patients with chronic cholecystitis can be rapidly detoxified by the use of cortical extract in preparing them for surgery and in preventing surgical shock. This has been attributed to a stimulation of liver cell activity with resultant normal function of these vital cells. Dr. Crile⁷ further cites the fact that in normal quiet life, adrenalin and the cortical secretion pass through the cortical veins into the portal circulation, where adrenalin is oxidized before passing into the general circulation; and that the only time adrenalin in a natural state enters the general circulation is as a defense mechanism during emotional stress, fear or some other similar state, and then only to activate the kinetic mechanisms of the body to defend actively or to flee. By this means, any substance which would stimulate normal liver cell activity would effect the synthesis of the chief body proteins which takes place in liver tissue. Since fibrinogen belongs in this group of protein plasma substances, activation of liver cell activity would tend to increase the amount and activity of this substance and thus favorably effect coagulation. Muntwyler⁸ in his review of plasma proteins cites the work of McMaster and Drury⁹ who show that fibrinogen is undoubtedly formed in the liver. These two workers, using hepatectomized rabbits, found that after replacing circulating blood with defibrinated blood, the control animals regenerated 90 per cent of the fibrinogen from five to six hours after it had been placed in circulation. The hepatectomized rabbits, with a reduction of from 65 to 80 per cent of the original fibrinogen content, showed a slight rise in four to five hours, followed by a marked progressive decrease. The decrease in fibrinogen content was progressive until death of the hepatectomized animals took place. From their work they logically conclude that without active liver tissue there is no regeneration of

fibrinogen in the blood plasma. A logical deduction based on these facts would be that if liver cell function were below normal, fibrinogen synthesis could easily be below normal and the fibrinogen level of the blood become subnormal in like manner. It would follow that coagulation would be adversely effected from this cause. Thus any substance which would favor normal liver activation should favorably effect coagulation by aiding in fibrinogen formation.

From an analysis of the action of cortical secretion or extract, both as an activator of liver function, or by its action in balancing body electrolytes with activation of the calcium ions, either one of these processes may be the reason for shortening the coagulation time of blood when the extract is given. These factors may either act in unison as they would if both liver and parathyroid functions are normal, or each factor of the secretion may act entirely by and of itself. In this way, it could activate either fibrinogen formation or utilization of the calcium already existing in the blood serum.

An extremely interesting side light regarding calcium metabolism is brought to mind by a case of hyperparathyroidism, with hyperthyroidism which the author operated upon in 1934. This case serves as a good example of what actually was found where an extremely high serum calcium existed. Extensive blood chemistry was done on this patient and serum calcium found on three consecutive days to be over twice normal. With such a finding it was expected to find a very rapid time of coagulation. Coagulation time was taken and, contrary to the expected, it was seven minutes. While this is not an exceedingly long coagulation time and exceeds the normal value only by two or three minutes, on the basis of calcium values alone a more rapid rate was expected. Following surgery, with the removal of nine large nodules of parathyroid tissue from the lower pole of the left thyroid, along with complete removal of the left thyroid lobe, blood calcium rapidly receded to

normal values. The patient improved rapidly and along with this recession in calcium and the patient's general response from surgery, the coagulation time dropped to normal limits. This was thought to be due to the more normal activity of liver tissue following the removal of the abnormal thyroid and parathyroid tissues with a resultant increase in fibrinogen content of the serum. This case has been presented as clinical evidence that an extremely high serum calcium alone is not sufficient for rapid coagulation but is dependent on liver function, as seen by McMaster and Drury in their hepatectomized dogs.

SUMMARY

1. Correlation of Table I shows a definitely favorable effect on the coagulation of blood following the administration of adrenal cortex extract to surgical patients. The reaction was present in 98 per cent of the cases taken from records in the order which they appeared. The average reduction in time for the fifty cases reported was 29.44 per cent. This group was sufficiently ill to warrant surgical procedures.

2. Table II shows a favorable effect in reducing coagulation time in the so-called normal individual. The average maximum reduction of time for the ten subjects was 38.4 per cent. The maximum reduction of time was reached at two hours after intramuscular injection of the extract. The difference in reaction being very small during the period from one to three hours after injection shows this period to be the best for surgery. It further shows that the reaction to the extract is prolonged for a period of over twenty-four hours; in this group there was a net reduction of 19.2 per cent at the end of the twenty-four hour period.

3. A review of the *modus operandi* of coagulation and present accepted theories regarding it reveals three distinct manners in which cortical secretion or extract may produce this result: (a) by increasing the

normal activity of the calcium ions of blood plasma; (b) by stimulation of liver cell activity with increased fibrinogen formation in the blood serum; and (c) by controlling the serum potassium levels at or near normal, and thus allowing the other two coagulation factors to act normally.

4. Citation of the extremely high calcium content of the plasma in a case of hyperparathyroidism with hyperthyroidism shows what may be expected in cases with a lowered fibrinogen content from lack of normal liver cell activity even though the calcium content be very high. The high calcium values were of no use to the body when liver function was impaired due to toxicity.

5. This work has now been in progress for over four years and covers a total of several hundred cases. During this time there has been no sign of embolism or thrombosis, as might have been expected, from lowering of the coagulation time.

6. It is hoped that through the recording of these facts, with citation of possible sequences producing the phenomenon, biochemic research may be stimulated which will reveal the true reactions taking place and producing a reduction of coagulation time by adrenal cortex extract or secretion.

Adrenal cortex extract (Upjohn) was used in treatment of all cases reported in Tables I and II.

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TREATMENT OF THE PERSISTENT OCCIPITOPOSTERIOR POSITION BY 180 DEGREE MANUAL ROTATION OF THE OCCIPUT*

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IN 1935 I¹ reported a series of 146 cases of persistent occiput posterior and occiput transverse positions in which I had performed manual rotation of the occiput by a modified Pomeroy maneuver. The modification consisted in applying the rotary force to the head and not to the shoulders. Both the initial and remote results have proved so gratifying that the report of a second series appears advisable.

Since the initial report I have performed this maneuver in 103 additional cases.

TABLE I

Para 0	Para 1	Para 2	Para 4
87	11	4	1
R.O.P.	R.O.T.	L.O.P.	L.O.T.
32	10	22	39

There were no maternal deaths nor were there any noteworthy maternal complications. There were four fetal deaths.

CASE I. The patient had been in labor many hours and the pelvis was contracted. By the time I was called in consultation the fetal heart could not be heard.

CASE II. The amniotic sac ruptured spontaneously and the patient went into labor shortly thereafter. The fetal heart tones were distinctly heard. After a few hours the fetal heart became inaudible. The cervix was thick and only one and one-half fingers dilated. Labor

was allowed to proceed until full dilatation. The patient was unable to make any further progress and manual rotation was performed. The child was delivered and death was found to be due to strangulation by a short umbilical cord (15 inches). Areas of fetal skin were macerated.

CASE III. I first saw this patient after she had been in labor for about seventy-two hours. Her temperature at the time was 103.6°F. by mouth. Pulse rate was 160. The pelvis was contracted and a foul smelling yellowish meconium was passing through the vagina. The fetal heart could not be heard. The cervix was four fingers dilated and the position R.O.P. Dilatation was completed manually. Manual rotation was performed with the understanding that if moderate forceps traction would not effect delivery craniotomy would be performed. However, despite the fact that the infant was very large, moderate forceps traction effected delivery. A large amount of gas escaped immediately following fetal delivery. I subsequently delivered this woman of a living child by cesarean section.

CASE IV. This patient was seen after she had been in labor for three days. The cervix was four fingers dilated and the fetus in L.O.P. position. Complete dilatation was effected manually and the occiput was rotated from L.O.P. to R.O.A. Forceps were applied and the child was delivered. The fetal heart was beating but the child failed to breathe. All efforts at resuscitation were unavailing. Autopsy could not be obtained.

Fetal Complications. There was one fractured clavicle, and three cases of Erb's palsy, in only one of which the palsy persisted. This occurred in a case of dry labor, in which the position was L.O.P. After full dilatation the occiput was rotated to

¹ ROSENFELD, S. *Am. J. Obst. & Gynec.*, 30: 364, 1935.

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R.O.A. and a child weighing 10 pounds 14 ounces was delivered. The massive shoulders became impacted and were delivered

cervix attempted rotation was still impossible because of the tight fit. The Scanzoni maneuver, however, proved successful and



FIG. 1. Correcting a right occipitoposterior to a left occipitoposterior position.

after considerable difficulty. A right Erb's palsy resulted. When last seen the child had been under the care of an orthopedist and was making satisfactory progress.

One patient could not be delivered by this maneuver. The patient was a primipara, 37 years of age and weighing about 235 pounds, whom I saw in consultation. Her membranes had ruptured a week previously and labor pains had been irregular since then. The consultation was requested because she had a severe chill and her temperature rose to 104. The patient looked very sick and the child very large. The fetal heart was distinctly audible. The cervix was thick and admitted two fingers. The head was engaged and the position R.O.P. After Dührssen's incisions in the

a 9 pound living baby was delivered. After two weeks mother and baby left the hospital in good condition.

Technique. The technique employed is exactly that described in the earlier communication. The "secret" now, as it was then, is overcorrection.

Unless there is an emergency no interference is practiced until the cervix is fully dilated. If, after full dilatation, delivery is deemed advisable, the patient is anesthetized, preferably with ether, and placed in the lithotomy position. The bladder is emptied by catheter and the perineum is "ironed out" with tincture of green soap.

In right occipitoposterior and right occipitotransverse position the operator faces the patient's right thigh, bends both

knees as much as is necessary, and acutely bends his body at the waist sharply to the left. He then inserts his whole right hand into the vagina and the forearm is pronated so that the thumb is below and posterior and the other four fingers above and anterior to the fetal head. The operator then slowly assumes the erect posture and as he does so he supinates his forearm thus forcing the occiput to rotate 180 degrees in the case of occiput posterior and in either case converting the position into the left occipitoanterior.

In left occipitoposterior and in left occipitotransverse positions the operator faces the patient's left thigh, bends his knees as above, and acutely bends his body at the waist to the right. He inserts his whole left hand into the vagina and proceeds as above described, rotating the head into the right occipitoanterior position as he straightens his body and supinates his forearm.

After completion of the rotation, which rarely takes more than half a minute, a nurse or an assistant exerts pressure on the fundus until the forceps are applied. While advisable, this procedure is not essential. I have frequently performed rotation where no assistant or nurse was available, where fundal pressure was not employed, and the head rarely rotated back to either its former or the corresponding anterior position. Should the head rotate back to or toward its former position, the maneuver is simply repeated. A cephalic application of the type of forceps to which the operator is accustomed is then made and delivery effected in the usual manner.

The contraindications to this procedure are appreciable contractions of the pelvis and disproportion. In cases of this sort where vaginal delivery is considered reasonably possible I prefer internal podalic version.

I have frequently displaced the head rather high while performing the maneuver,

but since I perform rotation only in fairly normal pelvis I found that this high displacement made very little difference in the delivery. Whereas I would under no circumstances apply high forceps in contracted pelvis, I do not hesitate to do so in these cases. In some of these cases where the head was unduly displaced podalic version is done from choice and not of necessity.

DISCUSSION

I have seen and have been able to follow well over 90 per cent of the mothers and babies of both series. The children, as far as I know, are all healthy and exhibit no abnormalities, deformities or diseases that can in any way be attributed to the method employed in delivering them.

I believe that overcorrection is the main reason for the success of this maneuver. It tends to prevent return to the original transverse or posterior position. This factor to my mind makes this maneuver superior to simple manual rotation. It seems to me self evident that this type of rotation is far less injurious to the maternal tissues than is the Scanzoni maneuver with its forceps rotation and double application. The Scanzoni maneuver is probably the strongest refutation of the fears proclaimed by some that this method of manual rotation might cause fetal injury. The Scanzoni method certainly accomplishes rotation by much more forcible means than does manual rotation and yet very few babies are injured by it. The objection to the Scanzoni maneuver has never been based on fetal, but on maternal, injury.

I also prefer this modification to the original Pomeroy maneuver because it is simpler yet just as efficient. This method of manual rotation is not difficult to master; I have taught many residents and house surgeons the technique and in a short time they were able to do all but the very difficult cases with facility.

UNUNITED FRACTURES OF THE CLAVICLE

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IT is unusual for a fracture of the clavicle to result in nonunion. This statement in itself expresses the commonly accepted opinion that clavicular fractures will unite whatever the type of treatment employed and sometimes in spite of it. Since the clavicle is one of the most difficult bones in the body to immobilize properly, this would appear paradoxical. Nevertheless, this difficulty is readily reflected by the multitude of splints which have been designed for the purpose of its immobilization and recommended to the profession.

In a review of the literature, we were unable to find many reports of the occurrence of nonunion in clavicular fractures. As a matter of fact, we were able to find only one authoritative article appearing in the medical literature in English during recent years, and this was the one recorded by Berkheiser in 1937. Berkheiser reported a series of nine cases in which nonunion occurred. In addition, he reviewed the anatomy of the shoulder and indicated how the association of lesions of the brachial plexus and vascular impairment in the adjacent arm in fractures of the clavicle could be accounted for by the proximity of the brachial plexus and the blood vessels of the arm, particularly the subclavian vein, to the most frequent site of fracture. This he has found to be at the junction of the middle and outer thirds of the clavicle. He pointed out certain axioms which apply to old cases of ununited fractures of the clavicle. Among these he mentioned that the severity of the initial injury and failure to obtain adequate immobilization are the two most common factors. Berkheiser also

expressed the opinion that the surest method by which to obtain union in ununited fractures of this nature is by means of the autogenous bone graft.

It is our purpose to report an additional series of ununited fractures of the clavicle and at the same time determine the best means of preventing and correcting this condition.

CLINICAL DATA

We wish to report a total of twenty cases of fractures of the clavicle with nonunion which were examined at the Mayo Clinic during the years from January, 1913, to October, 1939, inclusive. In Table 1, we have included a brief synopsis of each case. As may be seen, eleven of the twenty patients were male and nine were female. The average age was 35 years, the youngest being 2 years and the oldest, 60 years. In attempting to ascertain the severity of the injuries which were responsible for these particular fractures, we categorically divided the type of fracture force into severe and moderate. Of the severe types, there were ten, and of the moderate, five. Fractures resulting from automobile accidents were usually classified as severe, while simple falls were held to be responsible for the moderate types. In two cases, the type of fracture force was definitely not known, while in three others, the question of congenital pseudarthrosis entered into the picture; we were, therefore, unable to ascertain the complete etiologic circumstances. This particular group of cases will be discussed in further detail later. It is well to mention, in connection with the severity of fracture force, that there were no cases

TABLE I
UNUNITED FRACTURES OF THE CLAVICLE; CASE REPORTS

Sex and Age, Years	Date Seen	Duration	Cause of Fracture	Fracture Site	Previous Therapy	Symptoms*					Operation at the Mayo Clinic	Remarks	
						Neuritis	Sagging	Vein Press.	Pain	Motion			Limitat. Shou. Mot.
F 50	5/15/30	1 yr.	Auto collision	Right middle $\frac{1}{3}$	Bandaging and operation	..	..	..	+	+	+	None	Positive reaction for syphilis
F 49	3/4/30	16 mons.	?	Right middle $\frac{1}{3}$	?	..	..	..	..	+	..	None	Function excellent
M 57	9/23/25	5 mons.	Hit by an auto	Left outer $\frac{1}{3}$	None until 3 weeks, T splint	Nnt recorded					None	Positive reaction for syphilis; head injury	
F 57 Fig. 2	9/21/32	1 yr.	Auto collision	Left middle $\frac{1}{3}$	Immediate operation	..	..	..	+	+	..	None	Declined grafting
F 50	11/1/26	5 mons.	Auto collision	Right outer $\frac{1}{3}$	?	..	+	..	..	..	..	None	Parkinson's disease
M 35	10/20/31	2 yrs.	Falling crane	Left middle $\frac{1}{3}$	3 open† operations	+	..	+	+	+	..	Bone graft	Result: failure
F 35	11/21/25	4 mons.	Auto collision	Left middle $\frac{1}{3}$	Bandaging 7 weeks	..	..	..	+	+	+	Bone graft	Result: union
M 24	9/16/25	1 yr.	Fall	Right middle $\frac{1}{3}$	Manipulation-bandage	..	+	..	+	+	..	Open red., wiring	Result: failure
M 16 Fig. 4	6/2/26	14 mons.	Fall	Right outer $\frac{1}{3}$	Velpeau bandage	..	..	..	..	+	+	Bone graft	Result: union
M 34	10/23/22	4 mons.	Auto collision	Left middle $\frac{1}{3}$	Immediate operation	+	..	..	..	+	..	None	Declined grafting
F 38 Fig. 3	11/22/37	20 mons.	Fall	Right middle $\frac{1}{3}$	Splint and operation	..	..	..	+	+	..	Bone graft	Result: union
M 48	9/28/16	10 yrs.	Horse fell on part	Right middle $\frac{1}{3}$	Early ? — operation '16	..	..	..	+	..	+	None	Positive reaction for syphilis
M 22	6/15/21	8 mons.	Truck ran over	Right middle $\frac{1}{3}$	Traction	+	+	..	+	+	+	None	Function fair
M 60	10/10/38	45 yrs.	?	Right middle $\frac{1}{3}$	?	..	..	..	..	..	..	None	Function excellent
M 24 Fig. 1	7/5/38	2½ yrs.	Football injury	Right outer $\frac{1}{3}$	?	..	+	..	..	..	..	None	Function excellent
M 59	2/1/37	10/19/36	Train and auto coll.	Left outer $\frac{1}{3}$	Velpeau bandage	..	+	..	..	..	..	None	Psychosis
F 2	10/22/39	? fell 2 days before	Congenital ?	Left outer $\frac{1}{3}$	None	..	..	..	..	..	..	None	Function excellent
M 33	6/13/29	In infancy	? congenital ?	Left middle $\frac{1}{3}$	?	..	..	..	..	+	..	Bone graft	Result: union
F 3	7/23/29	18 mons.	? congenital ?	Right middle $\frac{1}{3}$	None	..	..	..	..	+	..	Bone graft	Result: union
F 8	6/7/13	5½ yrs.	Fall in bathtub	Right middle $\frac{1}{3}$	?	..	..	..	..	+	..	Open red., catgut	Result: unknown

* Legend of symptoms:

Neuritis: Symptoms of nerve irritation in adjacent arm. Sagging: Sagging of adjacent shoulder girdle. Vein Press.: Signs of interference with venous circulation. Pain: Tenderness on pressure at fracture site. Motion: False motion at fracture site. Limitat. Shou. Mot.: Limitation of motion in adjacent shoulder.

† Including bone graft.

of pathologic fracture included in this series of twenty cases.

According to Berkheiser, the majority of

syphilis. The test was not performed on three patients, while in the remaining fourteen the result was negative.



FIG. 1. Ununited fracture of the outer third of the clavicle.

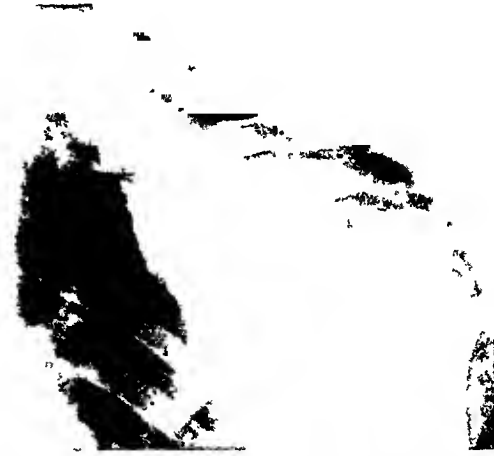


FIG. 2. Ununited fracture of the middle third of the clavicle with marked displacement of the outer fragment.

ununited fractures of the clavicle occur in the middle and outer thirds. We found this to hold true in our series. (Figs. 1 and 2.) In fourteen cases, the fracture was in the middle third, while in six it was in the outer third. In no case did it occur in the inner third. Twelve of the fractures occurred on the right side and eight on the left. There were no cases of bilateral involvement.

In reviewing the signs and symptoms which the patients in this series presented on examination, the most significant findings were as follows: false motion at the site of the fracture, pain on pressure at the site of the fracture, sagging of the shoulder girdle on the affected side, irritation of the nerves leading to the arm on the affected side, limited motion in the adjacent shoulder joint and interference with the return circulation of the arm on the affected side. In thirteen cases, false motion was present; in eight there was pain on pressure at the site of the fracture; five cases showed sagging of the shoulder; three gave symptoms which suggested neuritis in the adjacent arm; five cases showed limited motion in the shoulder joint, and one case gave evidence of vascular changes. In one case, there were no complaints or signs of dysfunction.

Of the twenty patients, only three gave positive reactions to flocculation tests for

In attempting to analyze the adequacy of therapy given these patients immediately after the injury and later, we were able to demonstrate only two cases in which the treatment could be definitely said to have been inadequate. In one case, the patient had received no form of treatment, while in another therapeutic measures had not been instituted until three weeks after the date of the injury. In still two other cases, the adequacy of treatment was questionable. In six cases the type of previous therapy was not determined. Of the eight patients known to have received some form of conservative therapy, with or without subsequent operation before coming to the clinic, two were treated by means of the conventional T splint, two by Velpeau bandaging, two by simple bandaging (since the detail of the immobilization in the latter two cases could not be fully ascertained from the records, the adequacy of their treatment is questionable), one patient was treated by manipulation plus bandage, while another was treated by means of traction to the arm. Of the six patients who had received open operative procedures before examination at the clinic, three had been subjected to some form of conservative treatment before operation. Two of the six had received immedi-

ate open reductions. Three others had been operated upon after conservative measures had failed to produce union. In one other not carried out on one patient, who was suffering from insanity, because of the anticipated difficulty in the postoperative care.

TABLE II
OPERATIVE CASES OF CLAVICULAR FRACTURES WITH NONUNION

Type of Procedure	Number of Cases	Int. Fixation			Graft Type			Recumbent Period			
		Wire	Cat-gut	Parham Band	Massive	Mass. and Osteoperiosteal	Osteoperiosteal	Bed 2 Wks. + Cast	Bed 4-6 Wks.	Bed 12-18 Days	Bed 9 Days
Open reduction with freshening of bone and fixation	2	1	1					2			
Results $\left\{ \begin{array}{l} \text{Union} \\ \text{Nonunion} \\ \text{Unknown} \end{array} \right.$	0			..							
	1	1						1			
	1		1					1			
Bone grafting	6	2	3	1	2	2	2		3	2	1
Results $\left\{ \begin{array}{l} \text{Union} \\ \text{Nonunion} \end{array} \right.$	5	2	3		2	1	2		3	2	
	1			1		1					1
Totals	8	3	4	1	2	2	2	2	3	2	1

case, bone grafting had been attempted elsewhere but had not produced union.

Of the total twenty patients having nonunion, only eight were subsequently operated upon at the clinic. For reasons which will be enumerated, twelve patients received no further treatment here. Three of the twelve patients, as has been mentioned, had strongly positive reactions for syphilis, and operation was deferred for the institution of appropriate medical therapy. However, none of the three returned for surgical treatment. In four of the patients, function was very good and the symptoms were minimal. For these reasons surgical intervention appeared to be optional and these four patients decided against further procedures. Two of the eleven patients for whom bone grafting seemed indicated declined operation for financial and other reasons. Operation was

The same held true in regard to another patient afflicted with Parkinson's disease. In the case of the two-year-old child with nonunion in the left clavicle, it was believed that bone grafting was not indicated at the time of examination because of her age and because of the absence of physical interference with function.

Eight patients were finally operated upon and the detail of procedure and result may be seen in Table II. Bone grafting procedures were carried out on six patients, while in two cases, the bone fragments were freshened up and realigned without the benefit of grafting. Internal fixation was secured by means of wire in one of these cases, while in the other, strong cat-gut was used. In the two cases in which bone grafting was not used, subsequent failure to unite occurred in one. The result in the other could not be determined.

Union occurred in five of the six patients who received bone grafts. It is significant that the failure to unite occurred in the patient who remained the shortest time in bed after operation.

The total results of all the operative cases showed that union resulted in five patients, nonunion in two, and the result was unknown in one.

COMMENT

There were four cases in which nonunion occurred during infancy. In only one of these cases was a definite injury of sufficient force recorded to have caused the original fracture. It has been our observation that the majority of infants with fracture of the clavicle show a greenstick type of fracture with little or no displacement. This has also been true in obstetric fractures in this bone. Owing to the elasticity caused by the highly cartilaginous content of the bones at this age, a complete transverse fracture with displacement is the exception rather than the rule. One would think that these factors would be conducive to very few nonunions. For this reason one naturally wonders why 4 or 20 per cent of our cases should have been nonunions occurring in infants unless there was some congenital weakness or defect originally present. We were led to believe that there might have been a congenital pseudarthrosis present in the case of the two-year-old girl whom we saw in October, 1939. The parents brought the child because of a fall which she had suffered the day before admission. Roentgenograms showed a fracture of the left clavicle at the junction of the middle and outer thirds, but this was obviously not a recent one. Since there was no history of previous injury or disability and because of normal function, it was believed that the deformity was congenital although one could not be sure. The same may or may not have been true in two other cases.

None of the four patients presented associated signs or symptoms which would suggest cleidocranial dysostosis, a well

known syndrome in which there is a complete or partial absence of both clavicles. Regardless of the causation of these infant fractures with nonunion, the treatment should be carried out along much the same lines as one would treat ordinary nonunion in the clavicle. Surgical intervention would appear to be indicated only in those cases in which there is obvious deformity, the presence of untoward physical discomfort and an interference with function. It is preferable to postpone operation until the patient is old enough to be handled without too much difficulty, although in the case of our three-year-old patient a bone grafting operation was successful.

Although there were ten cases out of the total twenty in which the patient had received severe injuries, there were, nevertheless, five cases in which the fracture force had been of the moderate or average type. It would appear that in these five cases the cause of nonunion resided chiefly in the lack of proper fixation rather than the severity of the initial injury. Adequate immobilization is certainly to be emphasized as one means of preventing nonunion. This fixation should be carried out with the best available means at hand. In cases where we have found it difficult to maintain proper alignment of the fragments with the conventional T splint, we have employed a Taylor brace with an outrigger attachment in the shoulder regions. This type of splint affords a comfortable means of pulling the shoulder girdle backward and holding it in place, especially in those patients who have an increase in the normal kyphosis of the spinal column.

In cases in which the patient has sustained severe types of injury to the clavicle, and in those in which other injuries interfere with the proper external splinting of the clavicle, early open reduction should be seriously considered. However, complete rest in bed with sandbags as an aid may be tried at first, provided the patient is able to cooperate sufficiently to remain flat on his back with the sandbags in place. If open reduction becomes necessary, wire

appears to be the most suitable agent at our disposal for this type of internal fixation.

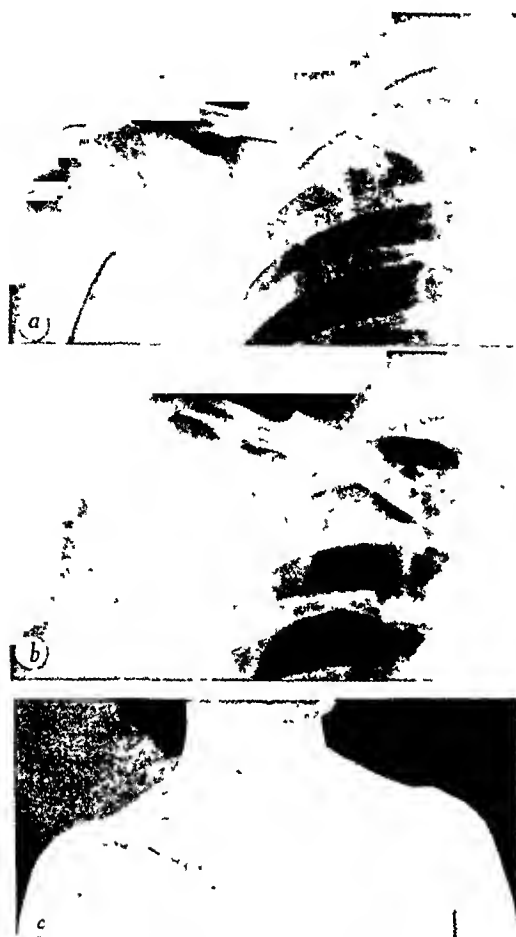


FIG. 3. Ununited fracture of the middle third of the clavicle; a, before operation; b, union after massive bone graft and wiring; c, photograph of the same patient after bone graft operation wire has been removed.

Contrary to Berkheiser's findings, we were able to demonstrate only one case in which an associated injury of the brachial plexus was present, and this was one for which two previous open reductions and one bone grafting operation had been performed. There were two other patients who complained of pains like those of neuritis in the involved arm, but we could not be sure that these were due to actual pressure of the fragments on the brachial plexus. Patients wearing Velpeau bandages often complain of the same type of discomfort. The patient who showed evidence

of pressure on the brachial plexus also presented signs of interference with the venous circulation in the affected extremity.

Although three of our patients with nonunion gave strongly positive reactions for syphilis, we do not believe that the failure to unite was caused by the presence of syphilis alone. In one case, the patient definitely did not receive the proper treatment for fracture and in another the adequacy of such treatment was open to controversy. Provided the proper medical measures are initiated, we believe that the presence of syphilis is not a contraindication to bone grafting.

In fractures of the clavicle with nonunion, the procedure of choice is some type of autogenous bone grafting, preferably the use of the massive type of graft. (Fig. 3.) Osteoperiosteal grafts may be used in combination with massive grafts, or they may be used alone in those cases where the contour of the fractured bone does not allow massive grafting. (Fig. 4.)

The means of internal fixation will, of course, depend on the type of graft, the difficulty in holding the fragments together and the gap which has to be filled in by new bone. Here again wire would seem to be the most dependable agent (Figs. 3 and 4) although beef bone and vitallium screws have been used to advantage by others in holding the grafts in place.

Perhaps the most important part of the treatment of fractures of the clavicle with nonunion is the proper immobilization of the patient following operation. The one patient in our series for whom union was not obtained by grafting remained in bed only nine days after operation. This is more than a coincidence since the quickest and best results were obtained in those cases in which the patients were kept in bed from four to six weeks following operation. Even if a shoulder spica cast is applied, complete rest of the grafted region cannot be insured unless the patient is flat in bed.

In reviewing this series of cases and from experience in the treatment of acute

clavicular fractures, we are of the opinion now that this period of complete immobilization should be at least five weeks

the literature have been few. Severe initial injuries and improper immobilization would appear to be the chief causes of



FIG. 4. Ununited fracture of the clavicle; a, before operation; b, union after osteoperiosteal bone graft and wiring.

following grafting. For this reason a certain amount of judgment should be exercised in the selection of patients for this regimen of treatment. One can obviously envision the difficulty in handling psychotic and non-cooperative patients under such a regimen. A patient with a psychosis or one with Parkinson's disease is hardly a suitable subject. On the other hand, we do not hold that all patients with nonunion of the clavicle should be refused the benefit of a grafting procedure if this period of complete immobilization cannot be carried out. However, it is certainly the ideal method and should be used in the majority of cases if union is to be expected.

After the hospitalization period, the part should still be supported by bandage or splintage until union is present clinically and roentgenographically. Union should take place within two to three months. If at the time of operation wire or metal has been used internally, its removal should be carried out at a later date.

SUMMARY

Nonunion in fractures of the clavicle is known to occur but the reported cases in

nonunion in this type of fracture. Twenty cases of fracture of the clavicle with nonunion are reported. A review of these cases tends to bear out this observation. Eight of the twenty patients were subjected to surgical procedures and in five, union was obtained while in two, nonunion resulted. The result was not known in one case. Of the six patients having bone grafting procedures, union occurred in five and nonunion in one. The importance of prolonged hospitalization with the patient in bed following bone grafting is borne out by the results. The best means of preventing nonunion in fractures of the clavicle is to be had by the early initiation of appropriate therapeutic measures. Fractures which fail to respond to the proper conservative measures should be reduced by open operative procedures. Autogenous bone grafting is the surest method of correction in instances in which nonunion has occurred.

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THE PREPARATION OF AUTOGENOUS BONE GRAFTS WITH OSTEOTOMES*

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EVEN though the first successful bone grafting operation was described by Jobi Meekren of Amsterdam in 1682,[†] the modern utilization of transplanted bone dates from Albee's pioneer operations which were reported in 1913. At the end of the nineteenth century Barth, Radzimowsky and others had studied the pathology of bone transplants in animals but to Albee credit is due for initiating the use of bone grafts in clinical surgery. In the ensuing twenty-five years autogenous bone grafts have been found to be indispensable in the repair of bony defects, in the healing of ununited fractures and in producing solid fusion of certain diseased joints.

The usual operation of bone grafting involves the removal of a portion of the tibial cortex by means of a circular motor saw and transplantation of the piece of bone to another part of the body. Henderson and Campbell have shown that "massive onlay" grafts, which are large pieces of cortical bone laid on a prepared area with wide medullary contact, are more successful than the original "inlay" type of grafts which are fitted into a carefully sawed groove.

During the past two years I have been removing autogenous bone grafts from the tibia by means of sharp thin osteotomes instead of the customary saws and have been impressed with their superior efficiency. In twenty-eight bone graft operations performed in this way on patients of all ages, the one failure was in a child with

tuberculosis of the spine with marked kyphosis. In this case the graft did not conform properly to the curve and hence did not heal solidly in its new position. The following advantages of this osteotome technique make it worth consideration in certain instances:

1. *High speed motor saws, when improperly used, burn the edges of the graft.* Unless the saw is kept cool with a stream of water or is swept along the bone in short strokes, much heat is generated. This sears the tiny blood vessels along the edges of the graft, polishes the surfaces and consequently delays revascularization in the new bed. In 1932 Ghormley and I performed a number of bone grafts to the spine in dogs and studied among other things the effects of burning the graft with an uncooled high speed saw. This inhibited bone growth in several instances. Of course, when orthopedic surgeons use a motor saw properly and eschew overheating there is no interference with healing of the graft.

2. *Grafts removed with osteotomes have raw irregular edges which heal quickly in their new locations.* If revascularization can take place rapidly all the bone cells do not die and the complete replacement of the graft by new cells is not necessary. Thus in this group of twenty-eight cases there seemed to be more rapid clinical union of the transplanted bone, which I assume to be due to more rapid reestablishment of normal blood supply to the bone.

3. *The best motor saws sometimes break down in the midst of an operation and a substitute method for removing a graft ensures no delay in the operation.* It is not uncommon also when operating in more than one hospital to find a defective

[†] Meekren transplanted a piece of bone from the skull of a dog into the defect in a soldier's cranium produced by injury in battle. It healed well but when the church heard of this infamy they required Meekren to remove the foreign bone under ban of excommunication.

* Presented before the Texas Railway Surgeons Association, May 8, 1939.

or outmoded saw which cannot be used efficiently at the time it is needed.

4. *The massive onlay graft as developed by Henderson and Campbell is eminently successful in the repair of bone defects and since it does not need to be fitted accurately into a perfect groove, its edges can be quite irregular. Therefore a "carpenter's fit" which can be achieved by saws is not necessary and a comparatively irregular graft is entirely suitable.*

OPERATIVE TECHNIC

A long incision is made over the antero-medial surface of the upper half of the tibia which divides skin, fascia, and periosteum down to the cortex of the bone. The tissues are then retracted so that the medial face of the tibia is exposed. (In adults it is not important to preserve the periosteum with the graft and even in children the presence or absence of periosteum seems to make little difference in the rate of healing of the graft.) With calipers or a metal ruler the size of the required graft is determined and is then outlined on the tibia with a sharp knife. (Fig. 1.) Cuts are made around the graft with sharp thin osteotomes and with only one blow of the mallet at each point. Previously multiple drill holes were made around the graft but this has been found to be unnecessary. The graft begins to come loose after the blows are made on the osteotome a second time and can usually be removed during the third cutting. (Fig. 2.) If instruments are sharp and the mallet blows are of moderate force this can be performed in patients of all ages without difficulty and with no great danger of splitting the tibia. If the graft is to be anchored with vitallium screws or bone pegs, it is well to determine the sites of the holes in the graft and drill them before removing it from the tibia.

After the graft is removed it is placed in a warm saline sponge while scraps of cancellous bone are curetted from the upper end of the medullary space in the tibia. (Fig. 3.) This soft highly vascular bone possesses great cellular growth powers

which hasten healing and stimulate the formation of new bone. If the bed where the graft is to be transplanted has been pre-

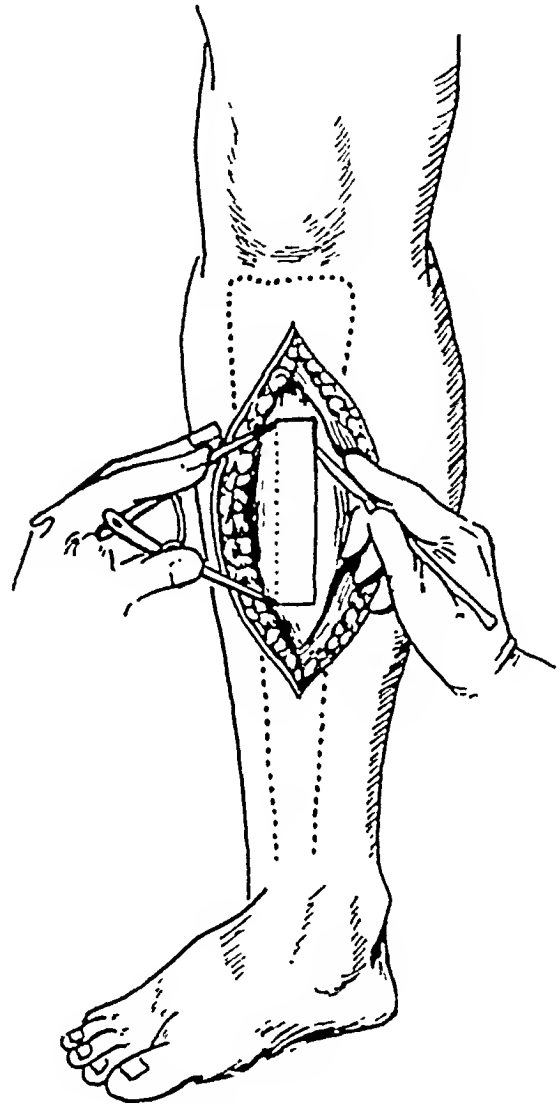


FIG. 1. Method of measuring and marking outline of graft on the inner face of the tibia.

pared in advance the bone can be placed in position without delay and the cancellous bone scraps packed around it. While bone grafts can be kept out of the body as long as necessary during such operations, they succeed better if they are transplanted with reasonable celerity.

Except in spinal fusions it is advantageous to anchor bone grafts securely to the adjacent fragments and to protect the extremity with a cast which immobilizes the long bone and the contiguous joints. Since Venable and I have demonstrated the electrolytic effects of metals in bone and have introduced the passive alloy

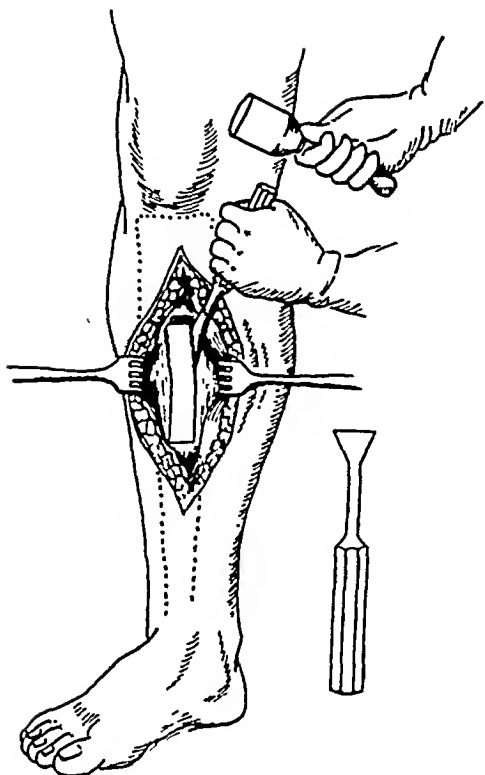


FIG. 2. Freeing the graft from the tibia by the use of thin sharp osteotome (see inset) and mallet.

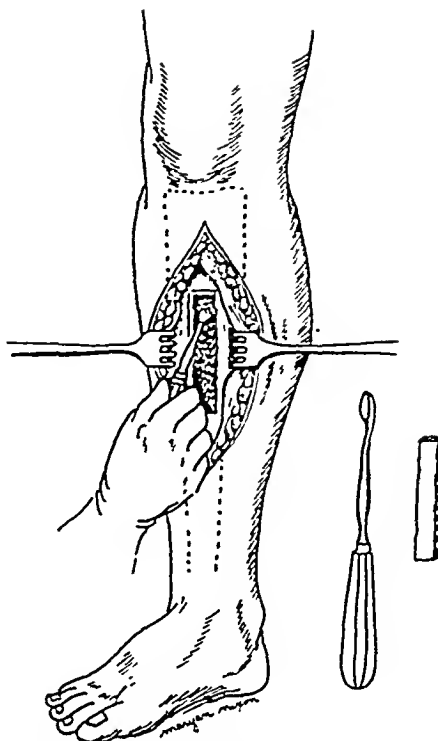


FIG. 3. Curettement of cancellous bone which is used to pack about the graft from the upper half of the medullary cavity of the tibia.

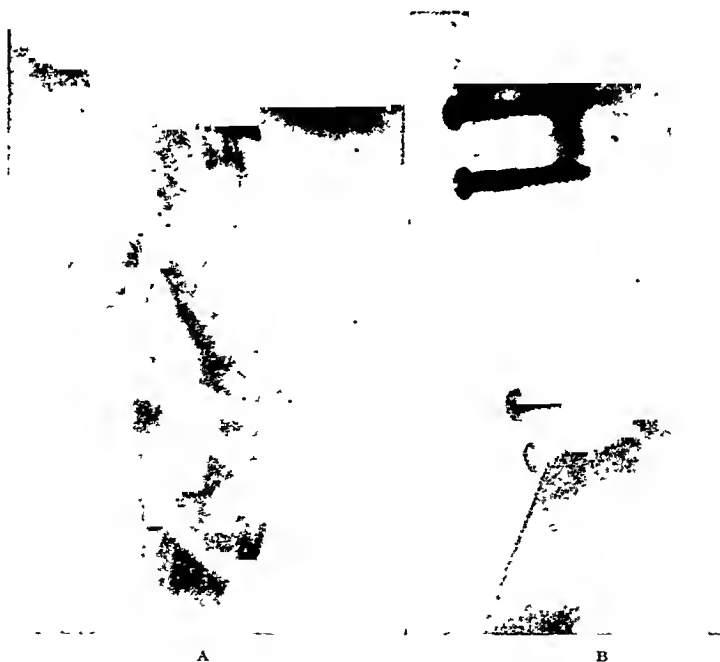


FIG. 4. A, H. C., age 51. Fracture of the left humerus six years previously. Complete nonunion with well developed pseudarthrosis in the middle of the shaft of the bone. B, false joint removed, ends trimmed and large cortical bone graft anchored to fragments with four vitallium screws.

vitallium into bone surgery, it is admirably suited for fixation of grafts. Sometimes I have used vitallium screws alone to anchor a graft (Fig. 4.) and at other times I have recessed the graft in the bone ends and placed a long vitallium plate over it. No matter what type of internal fixation is used it is quite important that the member should be immobilized in a cast or brace for several months or until the graft is solidly healed in its new location.

Patients sometimes complain of gnawing pain in the leg months after a graft has been removed from the tibia. In this series of twenty-eight patients there was the complication of pain in the leg for eight months in a boy of 14 and pain and limp for six months in the case of a man of 32. In the other cases there were no unusual complaints referable to the tibia from which the graft was removed.

TABLE I

BONE GRAFT OPERATIONS

Spinal fusion for paralytic scoliosis.....	6
Spinal fusion for Pott's disease.....	5
Lumbosacral fusion for spondylolisthesis.....	2
Fusion of flail joints (shoulder, ankle).....	4
Old ununited fractures.....	11
Humerus.....	3
Clavicle.....	3
Tibia.....	2
Femur.....	1
Radius.....	2
Total.....	28

The group of patients in which the aforementioned technique was used comprised persons of all ages and with various pathologic lesions requiring a bone graft. (Table I.)

As stated before there was one failure of union, in the case of a child with Pott's disease and marked dorsal kyphosis. Two of the patients complained of persistent pain in the legs for six months or longer. The others recovered uneventfully.

SUMMARY

Sometimes it is preferable to remove bone grafts from the tibia without the customary bone saw. This can be readily accomplished by the use of thin sharp osteotomes and mallet. In twenty-eight operations of all types in which such bone grafts were used results were successful in 96 per cent of the cases and there was only one failure of union of the bone graft. This method can be used on many occasions when more traditional equipment is not available.

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THE USE OF IMPLANTATION GRAFTS IN THE HEALING OF INFECTED ULCERS*

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THE principles involved in the utilization of this type of graft are: (1) The implantation of small sections of skin



FIG. 1. Case 1. Shows condition of wound ten months after accident, with raw surface on chest, axilla and upper arm extending to elbow.

into the granulating ulcer sufficiently deep so that they are not visible on the granulating surface of the ulcer (2) epithelization of the ulcer before or after the appearance of the graft on the surface of the ulcer. (3) the healing of the ulcerated area in the least possible time regardless of the cosmetic result of the area involved; and (4) replacement of the regenerated epithelium by the various other methods of grafting, provided the cosmetic or functional result is undesirable

REMOVAL OF GRAFT

The donor area is prepared with tincture of green soap, alcohol and ether. The region is properly draped, sterile vaseline is applied and an Olier-Thiersch graft is removed by whatever means the surgeon is accustomed to use. The size of the graft depends entirely upon the amount neces-

sary to implant the defect. This graft should be as thin as possible because we have found that the thinner the graft the quicker the stimulation to the granulating tissue. This skin is then transferred to sterile gauze saturated with normal saline, the usual precautions being taken not to misplace the graft. A tulle gras, wet saline, pressure dressing is then applied to the donor area and left intact for ten days. The graft is then cut into small segments, approximately 2 sq. mm. in size, and placed on a piece of rubber sheeting, board or towel. These small segments of skin are then ready for implantation.

THE ULCERATED AREA

On admission, the skin surrounding the ulcer is washed with tincture of green soap and covered with dressings saturated with normal saline. These dressings are left intact for twenty-four to forty-eight hours, depending not so much upon the amount of infection present as upon the convenience of the operator. There is no other preparation necessary, provided, of course, that granulation tissue is present.

In the operating room the wet dressings are removed and the area surrounding the ulcer is again washed with tincture of green soap, alcohol and ether. The ulcer itself is flushed with ether and is then ready for implantation. There is no necessity for the application of any antiseptic dye to the area involved prior to implantation. The area is then divided into small equal squares which are marked off with Bonney's blue or any other color dye; the size of these squares depends entirely upon the square inches of surface to be grafted.

* From the Department of Plastic and Reconstructive Surgery, Allentown General Hospital.

The small grafts are removed from the board with a point of a long straight needle, placed on the granulating surface, and by

defect is on an extremity it is immobilized with a splint. This may be applied before or after the implantation. The outer

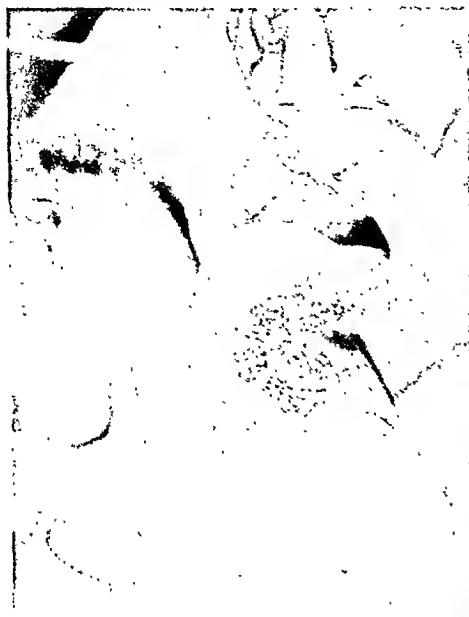


FIG. 2. Case 1. Shows condition of the wound twelve days after reimplanting the ulcerated tissue. The white spots within the ulcer show the implantation sprouting on top of the granulation tissue.



FIG. 3. Case 1. Shows condition of area forty-two days after second operation, when patient was discharged with wound completely healed.

means of the blunt or eye end of the needle the graft is pushed into the tissue keeping it as close to the surface as possible. The direction of the needle should be more in the parallel plane than in the perpendicular plane of the skin. This avoids unnecessary disturbance of the deep granulations and prevents greater bleeding. On withdrawal of the needle the graft frequently comes to the surface, but this can be avoided by keeping the point of the one needle in contact with the blunt end of the other needle as the latter is withdrawn.

The grafts are inserted at approximately $\frac{5}{10}$ cm. intervals and one square of the marked surface is grafted at a time. This avoids wondering whether or not a certain area has been implanted. After the whole area has been supplied with the grafts it is covered with a single layer of gauze, saturated with normal saline, and more gauze is then applied. Drainage tubes may be inserted within the gauze in order to keep it moist with normal saline. If the

dressings are changed each day, but the single layer of gauze is left intact from three to five days, depending on the amount of penetration of the exudate. At the end of this time the single layer of gauze is removed by soaking or saturating it with saline, and the area is given potassium permanganate baths, 1-5000, twenty minutes daily with the continuous application of normal saline in between. If the granulations are excessive, Dakin's solution or azochloramid in oil is applied instead of the saline. I frequently withhold the latter until the implants make their appearance. In seven to ten days the grafts appear as soft areas. These radiate and spread in the form of thin epithelium fusing with the adjacent implant until the whole area is covered. The length of time of epithelization depends on the size of the defect. After the defect is closed the area is dressed with vaseline and massaged twice daily.

The cosmetic and functional result of this grafted area depends entirely on the original location of the defect. Of prime

importance is to close the defect by the above method, and second, to excise the resulting covering of the defect and apply whatever graft is indicated.



FIG. 4. Case 1. Shows condition of patient twenty-four days after re-admission to the hospital for excision of scar tissue in axilla and application of intermediate grafts, the cubital surface having been previously repaired with the application of the same type of graft.

We found that in our clinic we save time as well as a great many intermediate and Thiersch grafts by first implanting the ulcer and healing it thoroughly and then applying the above grafts if necessary, instead of spending a few weeks trying to clean up the infected area, then making an application of a Thiersch or intermediate graft and not knowing how much of this graft will take, since the percentage of take is much higher in a fresh raw area than in an infected raw granulating area.

The question always arises as to when an infected granulating area is sufficiently prepared for the application of a free graft, and for that reason we have limited the primary application of a free graft to this type of defect. In some cases, however, in which we believe that the infection in the ulcer is sufficiently under control, we cover the ulcer for forty-eight hours without any application whatsoever. At the end of this

time the dressings are removed and examined. If the exudate is not excessive, we employ a Thiersch or an intermediate



FIG. 5.

FIG. 5. Case 11. Shows condition of leg at time of admission.

FIG. 6. Case 11. Shows the condition of ulcerated area fourteen days after the operation.

graft. If excessive, we employ the implantation graft. Whether an exudate is excessive or not depends on the experience of the operator. Cultures or smears mean nothing in the determination as compared to the above test. We must always determine first, whether the infected ulcerated area can be cleaned up properly, second, the length of time involved in doing this, and third, the amount of free graft that might take.

I am definitely convinced, however, that we can avoid a great deal of discomfort, distress and time by immediate application of implantation grafts as a primary treatment for an infected, granulating ulcer.

CASE HISTORIES

CASE 1. D. W., age 4 years, was admitted to the hospital with a history of having caught his arm in a wash wringer. He had an avulsion of the soft tissue involving the upper arm, elbow region, axilla and anterior portion of chest. Wounds became infected and various solutions were applied. Two months after admission a full thickness sieve graft was applied from the abdomen to both thighs by the general surgeon. Both the grafted areas and the donor areas became infected and the graft flooded off.

Ten months after admission the patient was referred to our department for attempted healing of the ulcerated area shown in Figure 1. Wound had a fairly healthy appearance but because of the history of repeated infections we

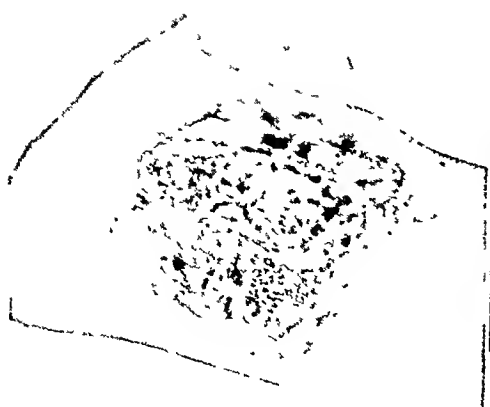


FIG. 7. Case III. Shows condition of chest and upper abdomen thirty-seven days after admission to hospital when she was referred to our department for skin graft.



FIG. 8. Case III. Shows condition of area four months after the above operation.

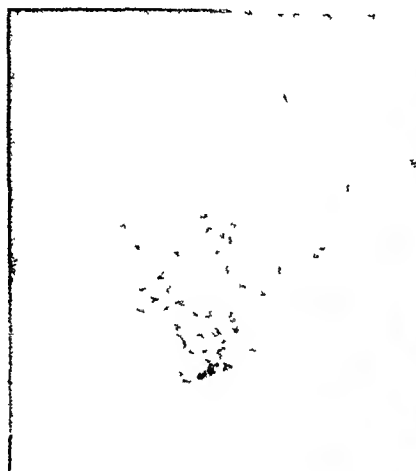


FIG. 9. Case IV. Shows condition of outer ankle, right foot, on admission three and a half months after a severe streptococcal infection of the leg.



FIG. 10. Case IV. Shows condition of inner ankle of right foot.

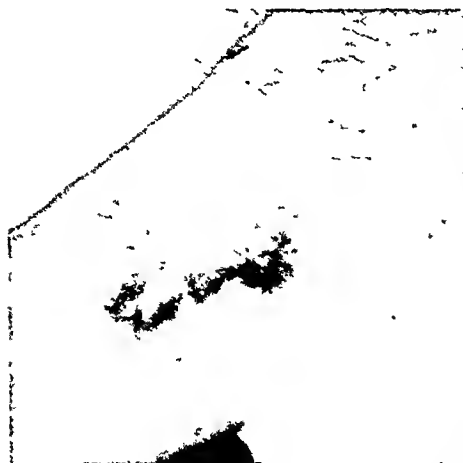


FIG. 11.



FIG. 12.

FIGS. 11 AND 12. Case IV. Both illustrations show condition of outer and inner surfaces of ankle eighteen days after operation. Both ulcers healed.

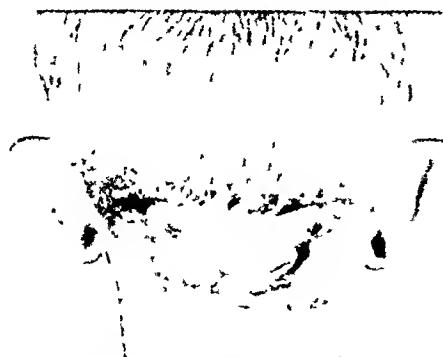


FIG. 13. Case v. Shows condition of infected ulcer in neck, when referred to our department.

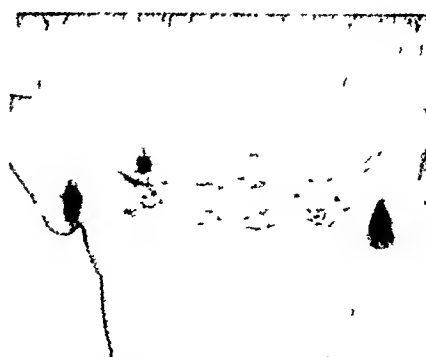


FIG. 14. Case v. Shows the condition of the ulcerated area six days after operation.



FIG. 15. Case vi. Shows infected granulating ulcer of the hand following a wringer accident



FIG. 16. Case vi. Shows the condition of the hand taken about a year later.



FIG. 17.

FIG. 18.

FIG. 19.

FIGS 17 AND 18 Case vii. Both illustrations show the condition of the infected granulating ulcer on admission to our department.

FIG 19 Case vii. Shows condition of arm twenty-six days after implantation of skin grafts

decided on a variety procedure. A Thiersch graft applied to the raw areas in the upper arm failed because of infection. A deep Staige-Davis graft applied to the chest portion of the wound also failed to take. Implantation grafts inserted in the granulating edges stimulated epithelization to the extent shown in Figure 2. Potassium permanganate dressings, 1-2500 were applied for ten days when some more implantation grafts were inserted in the remaining ulcerated area, Figure 2.

The wound gradually closed, and the patient was discharged forty-two days after the second implantation with wound completely healed, as shown in Figure 3. Scar contracture in the cubital space was excised with application of intermediate graft on a second admission. The web in the axilla was excised with application of an intermediate graft at a third admission to the hospital. (Fig. 4.)

CASE II. L. Y., age 23 years, had an infected ulcer on the left leg following an accident when six and a half years old. The patient spent practically all his life in the hospital in an attempt to heal leg. Grafting had been attempted at various hospitals but the ulcer persisted. We decided to heal the ulcer pri-

wearing of an elastic bandage. Unfortunately, the patient amputated his penis when discharged from the hospital during my absence



FIG. 20. Case VII. Same as Figure 19 taken at different angle twenty-six days after implantation of skin grafts.

and was admitted to a State institution. Recent reports from a member of the staff of this hospital show that the leg ulcer remains closed.

CASE III B. H., age 4 years, while playing with matches, ignited clothing and burned chest and upper abdomen. The patient was treated with tannic acid spray, but the wound became infected. Figure 7 shows condition of

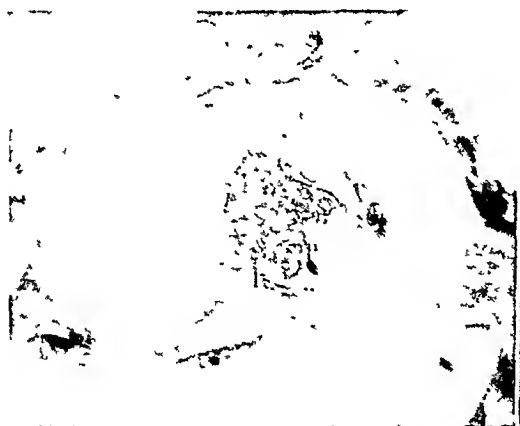


FIG. 21. Case VIII. Shows condition of ulcer at time of admission to our department.



FIG. 22. Case VIII. Shows condition of ulcer twenty-six days after implantation of skin grafts.

marily, if possible, and then transfer tube pedicle from abdomen to replace scar tissue of the leg. Figure 5 shows the condition of the ulcer on admission. Figure 6 shows the condition of the ulcer after implanting skin graft. Except for two small superficial areas the ulcer was healed.

The tube pedicles prepared on the abdomen are not shown in the photograph. We had a slight breakdown of the ulcer when patient started to walk but this was remedied by the

wound thirty-seven days after admission to hospital when she was referred to our department.

The wound was severely infected. Implantation grafts were inserted and the patient was discharged from the hospital with the area healed, fifteen days after the operation. During my absence no photograph was taken, but Figure 8 shows the condition of the area four months after the operation. There is a slight amount of keloid formation present but no evidence of ulceration. Should it become

ulcerated this area can easily be replaced by some other form of graft.

CASE IV. R. B., age 17 years, was admitted to our service with painful, infected ulcers on the right foot following a severe streptococcus hemolytic infection of three and a half months duration. The patient has had a great deal of treatment in this time but the ulcers refused to heal. Figure 9 shows condition of the ulcer on admission. Culture is still positive for *Streptococcus hemolyticus*.

Implantation grafts were inserted in the granulation of both ulcerated areas. Figures 11 and 12 show the condition of the ulcers eighteen days after the above operation. The wound healed completely. The outer ulcer broke down in its upper portion and the patient was allowed out of bed without support. Upon immobilization the area healed in about five days. An elastic bandage was then applied and ulcers are still healed thirteen months after the primary graft.

CASE V. A. H., age 60 years, was admitted to the hospital with a carbuncle in the neck. It was excised on two occasions after admission. Granulated tissue was stimulated but ulcer did not make very much progress in healing. He was referred to our department twenty days after admission or initial operation. Figure 13 shows condition of ulcer at that time. Implantation grafts were inserted into the granulating ulcer and the ulcer healed rapidly. Figure 14 shows condition of area six days after operation with ulcer healed except for a few moist areas which dried rapidly.

CASE VI. E. K., age 69 years, caught her hand in wringer of wash machine and had avulsion of dorsum of hand anteriorly to the proximal interphalangeal joints. The skin was replaced and sutured, but the portion of the dorsum of the hand became necrotic and was bathed in permanganate 1-2500 solution until the necrotic tissue separated.

Figure 15 shows condition of hand before implantation grafts were inserted. This operation was performed nineteen days after the original injury. The patient was discharged five days after grafting, with wound practically healed except for a few superficial raw areas which were completely dried in four days. No photograph was taken at that time. Figure 16 shows condition of the hand taken about a year later. It shows practically no deformity with scar tissue on dorsum of hand soft and friable.

CASE VII. R. S., age 7 years, burned his

right hand and arm in chimney of oil stove. The patient was treated for two months and then referred to our department for skin graft. The arm looked relatively clean; culture was positive for staphylococcus.

Figures 17 and 18 show condition of ulcer at this time. Three days after admission the granulation tissue was shaved and an intermediate graft applied from the right thigh. Practically all of this graft flooded off in four days with the exception of a large piece covering the cubital space. Potassium permanganate dressings were applied for fourteen days till the condition of the patient warranted a second operation. Implantation grafts were then inserted.

Figures 19 and 20 show the condition of the arm twenty-six days after the second operation. The small ulcerated area that was still visible healed very satisfactorily with permanganate soakings. Texture of covering was satisfactory. A recent operation with intermediate grafts to replace the scar tissue in the region of the fingers has also proved satisfactory.

CASE VIII. S. I., age 62 years, burned her left temporal region with a curling iron fifteen years ago. This never healed entirely and radium had been applied.

Figure 21 shows condition of wound sixty-seven days after wide excision performed with electric therapy when patient was referred to our department for the healing of the infected ulcer. Implantation grafts were inserted the following day without any preparation. Holes were drilled in the anterior portion of the skull where the bone was exposed and no granulation tissue was present. We decided to leave the eye reconstruction to a future date. Figure 22 shows the condition of the area twenty-six days after the operation with ulcer completely healed.

Unfortunately, the nodules seen at the inferior portion of the area began to ulcerate a week after the closure. This area was redessicated.

SUMMARY

Infected granulating ulcers are at times difficult to heal regardless of the method employed.

I have attempted to revive a method that has proved very effectual in our hands, and has replaced largely the use of a great many chemical and biological preparations.

I believe that the early implantation of grafts is the solution to the healing of this type of ulcer, regardless of the location and the cosmetic or functional result. I have particularly stressed the healing of the ulcer primarily, and then replacement if necessary by some other form of graft in order to avoid partial or total loss of the graft.

Finally, there is very little deformity in the donor area regardless of the size of the

graft removed. This is a decided advantage in that this area can be used again if necessary.

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SKIN grafting at the proper time will shorten the convalescence in many cases (of pseudomycotic ulcer). A warning should be issued, however, namely: the ulcer should be free of the *Micrococcus myceticus* upon culture before the grafts are applied.

From—"The Practitioners Library of Medicine and Surgery" 1940 Supplement (D. Appleton-Century Company).

SURGICAL REMOVAL OF HEMANGIOMA OF THE FACE

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THE removal of hemangiomata or port-wine stains is essentially important for cosmetic reasons as these marks on the face not only conspicuously disfigure the individual but create marked inferiority complexes. Hemangiomata of this type may be classified into three categories: the capillary hemangioma, the cavernous and the compact. That most frequently seen by the plastic surgeon is the capillary or port-wine stain type, the pathology of which may be attributed to the failure of certain cells in the vascular layer of the embryo to establish contact with the developing vascular network. Such cells proliferate, become vacuolated but in a disjointed state. These capillaries do not proceed beyond the stage of a mesh of minute blind channels, through which the blood of the general circulation does not pass. The lumen of the vessels in a tumor of this type is empty and contains a few immature or degenerated corpuscular elements. Such hemangiomas may range from as small as a minute speck of looped capillaries to a mark covering the entire side of the face and neck. Females are afflicted twice as often as males. The color varies from pale bluish red to dark purple, accounting for the name port-wine marks. They are as a rule confined to one side of the head. The cavernous type appears as a thick, tumor-like growth producing ugly deformities.

For the attainment of the best cosmetic results, it is essential to select the proper method of treatment. Since these tumors are usually benign and conspicuous, surgical excision should be the method of choice. Radium treatment is prolonged and may cause complications, among which are telangiectasia, pigmentation, excessive blanching, dense sclerosis or atrophic

scarring, where there is excess irradiation or improper screening. There may also be a secondary malignant change in areas of radiodermatitis. This is not uncommon. However, radium treatment is employed with favorable results in the treatment of angiomas in children since these tumors are highly sensitive to treatment while they are actually growing in early life; when the growth ceases, the sensitivity decreases. After a few years, the blood vessels of which these tumors are composed are little if at all more sensitive than normal tissue. The radium technique involves difficulty since children are uncoöperative and there is the possibility of interference with growth or the development of malignancy.

Electrocoagulation, which affects small nevi, has also been used. However, it is not best for large nevi because it requires long treatment and invariably produces conspicuous scarring which must be corrected by surgery. In the past, heated needles and pressure were used, but this invariably caused the formation of fibrous tissue in the tumor area. In the cavernous type, injections of sclerosing substances such as iron compounds, chloryl hydrate, silver nitrate, alcohol, citric acid, quinine and ethyl carbonate, boiling water and corrosive mercuric chloride, have been used for many years. Accidents have occurred in the form of sepsis or coagulation of blood, causing thrombophlebitis, thrombosis and embolisms. Carbon dioxide snow, electrolysis, ligation of efferent blood vessels, curettage and cauterization have also been used with varying results.

Although the cosmetic indication is the most important to the plastic surgeon's viewpoint, eradication of these angiomas is equally important for other reasons, as

the nevus may undergo rapid extension, interfere with function, may ulcerate traumatically or spontaneously, may undergo serious hemorrhage or become infected and may possibly undergo malignant change.

There are three types of skin graft which the surgeon may utilize for the plastic correction of hemangiomata. The free, full thickness (Wolfe-Krauss) graft is the method of choice, as the tubed pedicle flap requires extensive hospitalization, produces more conspicuous scarring and does not maintain the surface level of its surroundings. The thin epidermic graft tends to take on a tint and also will not maintain the surface level of the surrounding skin. Furthermore, its contractibility is too great.

In performing the skin transplant it is important to select skin which matches in color, conforms to the texture and Langer's lines as well as hair distribution of the recipient area. It is advisable before operation to take a complete blood and blood platelet count, for when the latter is too low, the danger of oozing is increased. Incidentally, irradiation of the spleen in amounts of $\frac{1}{2}$ to $\frac{1}{10}$ erythema dose may be employed. The coagulation time of the blood is hastened twenty-four hours after irradiation. Intravenous injection of calcium or a hemostatic preparation the day before operation may in some cases be advisable.

The donor area is cleansed the night before operation with green soap and water, followed by sulfuric ether. It is then covered with gauze until the operation, as it is essential that the oxygen and sulfur content be maintained at normal levels in order not to destroy the turgor of the skin. General anesthesia is preferable. The recipient area is cleansed with iodine and alcohol. A sterile, transparent, perforated lint is placed over the defect area and with 5 per cent brilliant green dye, the exact pattern of the nevus is outlined. The edges around the margins of the lint are trimmed off, thus forming the finished pattern. With a sharp blade, the nevus is excised in its

entirety. During the course of this dissection, the larger bleeding vessels are controlled by fine pointed hemostats and



FIG. 1. Graft fixed into new bed with numerous interrupted fine silk sutures.

ligated with fine silk triple zero catgut. The capillary oozing, which is considerable, is best controlled with hot wet sponges applied for five minutes to allow clots to form in the lumen of the vessels. The recipient area must be thoroughly dry before the application of the graft. This area is temporarily covered with a saline dressing.

Immediately before the operation, the preoperative dressing over the donor area is removed and the area is cleansed with green soap and water, then swabbed with sulfuric ether. The pattern is then placed over this area, respecting Langer's lines, and is then delineated with brilliant green dye. The skin is excised through its full thickness. For this purpose, a very sharp blade is used so that there are no ragged or bevelled edges to the graft. While undermining, tension sutures are inserted at the corners described by the pattern. These serve for lifting and handling the graft and eliminate the traumatization of tissue caused by grasping with forceps or other instruments. The donor area is temporarily covered. The graft, with raw surface upper-

most, is lifted by means of the tension sutures to a board, is held under traction by straight needles, and the subcutaneous fat

ing is used for another week. The temperature curve should be watched closely, and if any infections or secretions are discovered



FIG. 2. Extensive pigmented nevus covering entire side of face.

is dissected completely, down to and including a thin layer of corium.

The graft is transplanted over the recipient area with the aid of tension sutures. It is anchored in place with several stay sutures to insure accuracy of position and even tension, and fixed into its new bed with numerous fine silk, interrupted sutures. (Fig. 1.)

The dressing of the graft area, an important step in the operation, must be non-adherent, protective, capable of exerting firm, even pressure and of maintaining immobilization. First, vaseline gauze or gauze impregnated with 5 per cent zero-form is placed in position. Over that, several smooth layers of dry gauze, then a moist marine sponge, followed by several layers of dry gauze. This dressing is fixed in place by bandage and adhesive strips and left undisturbed for ten days, at which time the graft can be inspected. A similar dress-



FIG. 3. Four weeks later, following excision of nevus and transplantation of free, full thickness skin taken from the region of the left iliac crest.

beneath the graft, remedial measures should be taken immediately. After the discontinuance of the dressing and removal of the sutures, the grafted area should be exposed to the air and gentle massage applied to improve the circulation and soften the graft and the marginal scars. The donor area is closed by wide undermining of the skin and approximation of the loose margins by skin clips. Interrupted sutures are inserted, leaving a straight suture line. A vaseline dressing is applied.

When the graft is near the mouth it is necessary to obtain complete immobilization and the patient is therefore fed intranasally by Nelaton tube, intravenously with 5 per cent glucose, 3000 c.c. every twenty-four hours, and peptonized milk by Murphy drip, 2 ounces every four hours.

SUMMARY

1. The removal of nevi is essential for pathologic, cosmetic and psychologic reasons.

2. Since radium treatment is prolonged and may cause complications, and older methods have become antiquated, surgical excision is the method of choice.

3. The use of the free, full thickness graft is preferred and the operative technique is described.

4. Whenever possible, one section of skin should be used for the graft in order to avoid excessive scarring and to maintain equality of surface level and consistency of color.

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TAKING into consideration our paucity of knowledge as to the cause of cancer and the multiplicity of destructive technics advocated for the cure of cancer, it is only fair to say that the main emphasis in the whole cancer problem should be placed on its early diagnosis. The responsibility for this rests: (1) With the patient with persistent, trivial symptoms coming early for examination, and (2) with the first doctor consulted being cancer-conscious.

From—"The Practitioners Library of Medicine and Surgery" 1940 Supplement (D. Appleton-Century Company).

A STUDY OF THE RÔLE OF AMINO ACIDS IN CLOT RETRACTION

THE EFFECT OF METHIONINE IN RESTORING NORMAL CLOT RETRACTION AND CONTROL OF BLEEDING IN ESSENTIAL THROMBOCYTOPENIC PURPURA

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THE failure of blood clot to retract within the normal limits, a notable lowering of the platelets in the circulating blood and a prolonged bleeding time are outstanding laboratory manifestations in essential thrombocytopenic purpura. It is the consensus of opinion that an adequate supply of normal platelets is essential in order to allow the normal physiologic processes concerned in the control of bleeding to operate. Comparatively few platelets are required to bring about coagulation, but considerable numbers are necessary to ensure proper clot retraction under ordinary circumstances. Nevertheless, clot retraction is often found to be efficient despite a precipitous fall in platelet count, often encountered following the phenomenal rise in the platelets immediately after splenectomy. Most investigators believe that the platelets are essential for development of clot retraction; others are of the opinion that their presence is not necessary to hasten the contraction of the fibrin masses. Glanzman¹ believes that the substance producing retraction is an enzyme which he called "retractozyme." This phenomenon, however, is scarcely compatible with the generally accepted action of enzymes, as clot retraction may still occur at 40°C. The writer is of the opinion that, although clot retraction is due to condensation of the fibrin, the process is greatly supported by a substance liberated during the disintegration of the platelets and is wholly independent of the action of thrombokinase. In essential thrombocytopenic purpura, the chemical composition of the

platelets is altered, thus allowing for their prompt removal by the spleen and other reticulo-endothelial structures. The substance liberated is wholly unsuitable for and antagonistic to normal clot retraction. With the latter reasoning as a working hypothesis, investigations as outlined in the text of this paper were undertaken.

EFFECTS OF CYSTINE AND CYSTEINE UPON CLOT RETRACTION IN VITRO

Cystine is a normal constituent of blood platelets and is believed to augment the stability and resistance of the platelets. In the normal metabolic degradation of cystine in the body, two molecules of cysteine are formed as the first step in its reduction. The next step is believed to be an oxidative deamination, ammonia being converted to urea. Likewise, cystine is the precursor of taurine and it is believed, that in the body conjugation of the cholic acid occurs with cysteine and the conjugated product is then oxidized to taurocholic acid, a very important constituent of bile. Both the excretion of bile and the property of conjugation are indispensable functions of the liver. Apparently the liver plays a very important rôle in the intermediary metabolism of cystine, and any interruption of that metabolism would obviously be reflected by the effects of cysteine upon normal physiologic processes. The effect of cysteine upon clot retraction in vitro is diametrically opposed to that of cystine. Cysteine inhibits and even abolishes clot retraction, whereas, cystine acts as an antagonist to the antiretractile effect of cysteine upon blood clot. Figures

1 and 2 illustrate that 150 mg. of cysteine added to 5 cc. of blood abolishes clot retraction for more than twenty-four hours.



FIG. 1. Illustration showing control test tube containing 5 cc. of normal blood with complete clot retraction at the end of one hour and thirty minutes and five succeeding test tubes each containing 5 cc. of normal blood plus increasing amounts of cysteine ranging from 5 to 150 mg. All showed complete retraction at the end of one hour and thirty minutes except the specimen containing 150 mg. of cysteine, which did not retract after twenty-four hours. One hundred fifty mg. of cysteine was proved to be the constant minimum amount which, when added to 5 cc. of normal blood, abolished clot retraction for more than twenty-four hours. Coagulation time was not impaired.

tively, to each of four test tubes containing 5 cc. of normal blood did not reveal any significant departure from the normal clot

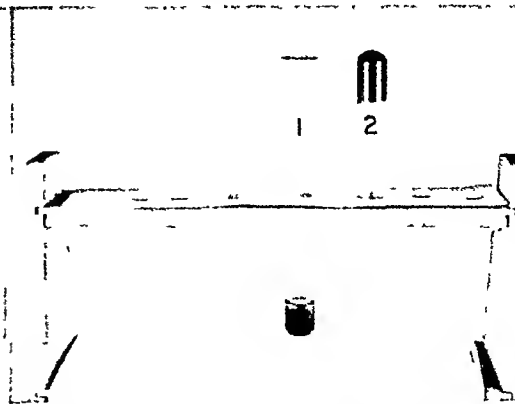


FIG. 2. Illustration showing test tube (1) containing 5 cc. of blood with complete retraction in one and one-half hours and test tube (2) containing 5 cc. of blood to which 150 mg. of cysteine was added with failure to retract at the end of twenty-four hours.

retraction time. (Table 1.) One hundred fifty mg. of cysteine was established as the constant minimum amount which abolished clot retraction in 5 cc of normal blood for

Figure 3 illustrates that 150 mg. of cystine antagonizes the antiretractile effect of 150 mg. of cysteine upon 5 cc. of blood as evidenced by restoration of normal clot retraction within three hours.

EVALUATION OF THE COMPARATIVE EFFICACY OF THE AMINO ACIDS, METHIONINE, CYSTINE, GLYCINE AND TYROSINE AS ANTAGONISTS TO THE ANTIRETRACTILE EFFECT OF CYSTEINE UPON BLOOD CLOT

Individuals from whom blood specimens were taken were carefully examined and found free of any organic lesion or blood dyscrasia. All blood specimens were taken before breakfast and the diets were regulated and controlled as the individuals were attached to the hospital personnel. One hundred fifty mg. each of methionine, cystine, glycine and tyrosine added, respec-

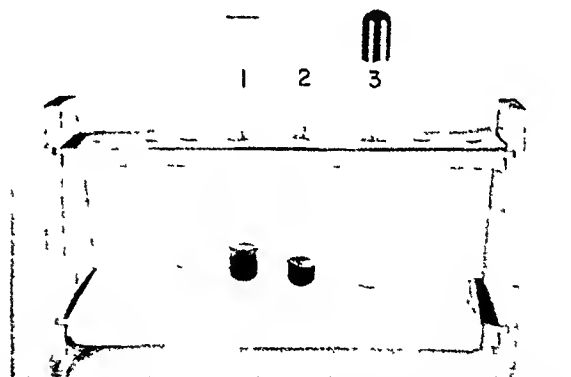


FIG. 3. Illustration showing the antagonistic effect of cystine upon the antiretractile property of cysteine in blood clot. (1) Five cc. of normal blood to which 150 mg. each of cystine and cysteine were added with resulting complete clot retraction within three hours. (2) Control specimen of blood which retracted completely within two hours. (3) Five cc. of blood to which 150 mg. of cysteine alone was added showing no retraction after twenty-four hours.

more than twenty-four hours. This standard was arrived at by testing the blood of twenty normal subjects against cysteine by the method depicted in Figure 1. One hundred fifty mg. of cysteine was therefore

used as a constant in the evaluation of methionine, cystine, glycine and tyrosine as antagonists to the antiretractile effect of cysteine upon blood clot. The study of Tables II, III, IV, and V showed that 150 mg. of methionine, cystine and glycine, respectively, constituted the minimum amounts that antagonized the cysteine constant with resulting complete retraction of the clot within three hours. Moreover, by increasing the amount of methionine from 150 to 200 mg., the time of complete retraction was reduced from three hours to one hour. The action of tyrosine as an antagonist to cysteine was definitely weak, and clot retraction was incomplete at the end of twenty-four hours.

MINIMUM AMOUNTS OF METHIONINE,
CYSTINE, GLYCINE AND TYROSINE
REQUIRED TO RESTORE NORMAL
CLOT RETRACTION IN PURPURIC
BLOOD IN VITRO OF FIVE
CASES OF ESSENTIAL
THROMBOCYTOPENIC
PURPURA

A study of Table VI, Case L. E., essential thromboeytopenic purpura in which there was no clot retraction at the end of twenty-four hours showed that 50 mg. of methionine and cystine, respectively, restored complete clot retraction within six hours. Moreover, by increasing the amount of methionine and cystine from 50 to 150 mg. the time of complete clot retraction was reduced from six hours to three hours. (Table VII.) One hundred fifty mg. of glycine restored complete clot retraction within six hours and thus proved less potent than the equivalent amounts of methionine and cystine. Tyrosine failed to restore complete retraction at the end of twenty-four hours. The comparative evaluation of the effectiveness of methionine, cystine, glycine and tyrosine with regard to clot retraction in four additional cases of essential thromboeytopenic purpura was compiled in Table VIII, which indicates that methionine and cystine are most effective in the restoration of clot retraction to

the normal levels, glycine less effective and tyrosine, ineffective. Since the amino acids are products of protein metabolism, and thereby dependent upon normal liver function, further investigation of liver function with regard to desaturation of fatty acids was undertaken. The following are the respective iodine numbers of seven proven cases of essential thromboeytopenic purpura, viz.: 53.5; 57.6; 57.2; 55.3; 45.5; 57.7; zero; the last case, which showed a complete failure of the liver to desaturate the fatty acids, was fatal. The iodine numbers in these cases were determined under the same controlled conditions as described in the text of this paper. These figures indicate the highly saturated state of the fatty acids of the blood in essential thromboeytopenic purpura when compared with the normal iodine number of 88.5, determined by Boyd.² Obviously, liver function is seriously impaired in essential thromboeytopenic purpura. Likewise, the metabolism of methionine and cystine apparently plays a very important rôle in the normal physiologic processes of clot retraction.

EFFECTS OF METHIONINE AND CYSTINE
UPON THE CLINICAL COURSE OF FIVE
CASES OF ESSENTIAL
THROMBOCYTOPENIC
PURPURA

Despite the fact that both methionine and cystine were effective in restoring clot retraction in vitro in essential thromboeytopenic purpura, a study of the effectiveness of methionine and cystine, respectively, upon the clinical course of five cases of essential thromboeytopenic purpura leads one to believe that methionine is more effective in the control of bleeding and the restoration of normal clot retraction. Following are the histories and clinical courses of five patients with essential thromboeytopenic purpura treated with adequate amounts of methionine and cystine, respectively.

CASE I. (B. B.) female, age 16, was first seen August 13, 1936. Menses began at the age

of 11; she enjoyed a normal cycle for one year and subsequently menstruation became progressively prolonged, bleeding more profuse, with intervals of a few days of spotting which she considered some relief. At the same time the patient noted "black and blue marks" over her body at various times and bleeding from gums particularly in the morning after brushing teeth. There was no history of acute infection or chronic suppuration or ingestion of drugs preceding the onset of vaginal bleeding. Rectal

venom serum. The latter was followed by a rise in the platelet count to 140,000, with no significant change in bleeding time, clot retraction or any evidence of clinical improvement with regard to vaginal bleeding. On October 12, 1937, vaginal bleeding reached alarming proportions and blood examination revealed: platelets, 70,000; hemoglobin, 50 per cent; red blood count, 3,450,000; bleeding time, ten minutes; no clot retraction in twenty-four hours; and iodine number, 62.6.

TABLE I

THE ADDITION OF 150 MG. OF CYSTINE, METHIONINE, GLYCINE AND TYROSINE, RESPECTIVELY, TO 5 CC. OF NORMAL BLOOD SHOWED NO SIGNIFICANT CHANGE FROM THE CONTROL SPECIMEN WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	1½ Hours	2 Hours	
Normal blood 5 cc.	4	Serum — Retr. none	Serum ++ Retr. none	Serum ++++ Retr. comp.	
Cystine 150 mg. Blood 5 cc.	4	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. incomp.	2½ hr. Serum ++++ Retr. comp.
Methionine 150 mg. Blood 5 cc.	4	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. incomp.	2½ hr. Serum ++++ Retr. comp.
Glycine 150 mg. Blood 5 cc.	4	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. incomp.	2½ hr. Serum ++++ Retr. comp.
Tyrosine 150 mg. Blood 5 cc.	4	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. incomp.	2½ hr. Serum ++++ Retr. comp.

examination did not reveal any significant pelvic pathology. Upon physical examination extensive areas of ecchymosis and petechiae were seen over the chest, thighs, legs and neck. Active vaginal bleeding and large blood clots were expelled from time to time.

Laboratory Data: Platelets, 68,000; no clot retraction in twenty-four hours; tourniquet test, positive; coagulation time, five minutes; bleeding time, ten minutes; hemoglobin, 58 per cent; red blood count, 3,970,000; white blood count, 4,400; polynuclear leukocytes, 59; lymphocytes, 30; monocytes, 9; eosinophiles, 2; central achromasia, poikilocytosis and anisocytosis; therapy consisted of many blood transfusions, ovarian extract, calcium and anti-

Ten cc. of venous blood was withdrawn and 5 cc. of blood was added to each of two test tubes, one of which contained 150 mg. of cystine, while the other served as the control. The clot in the latter did not retract in twenty-four hours, while the clot in the former retracted completely within three hours. At this time 5 Gm. of cystine in capsules was administered daily up to January 5, 1938, at which time vaginal bleeding ceased. However, during the three months of oral administration of cystine, vaginal bleeding continued with exacerbations from time to time, and clot retraction and platelet counts showed no appreciable change from the original data. Simultaneous with the cessation of bleeding on January 5,

hours. The vaginal bleeding had ceased though bleeding from gums persisted. On May 24, vaginal bleeding recurred and progressively became more intense reaching alarming proportions at times, despite numerous transfusions and all known therapy. By the beginning of June, hemoglobin dropped to 6 Gm., red blood count, 2,000,000; platelets, 60,000; coagulation time, four and one-half minutes; bleeding time, ten minutes; and no material change in white blood count.

from the gums and vagina steadily, though rather slowly, decreased. On August 10, vaginal bleeding ceased and slight bleeding from gums persisted. At this time hemoglobin rose to 7.5 Gm.; red blood count, 2,850,000; platelets, 120,000; coagulation time, four minutes; bleeding time, ten minutes; clot retraction began in eight hours and was complete in twenty-four hours. On August 14, patient began to stain vaginally and apparently had a normal menstrual period for the following five days. On

TABLE III

THE EVALUATION OF INCREASING AMOUNTS OF CYSTINE AS ANTAGONISTS TO THE CYSTEINE CONSTANT WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Normal control Blood 5 cc.	+	Serum ++ Retr. incomp.	Serum +++ Retr. comp.	Serum ++++ Retr. comp.	
Cystine 150 mg. Blood 5 cc.	+	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Cystine 50 mg. Cystine 150 mg. Blood 5 cc.	+	Serum - Retr. none	Serum + Retr. none	Serum ++ Retr. none	Serum ++ Retr. none
Cystine 100 mg. Cystine 150 mg. Blood 5 cc.	+	Serum + Retr. none	Serum ++ Retr. none	Serum ++ Retr. incomp.	Serum ++ Retr. incomp.
Cystine 150 mg. Cystine 150 mg. Blood 5 cc.	+	Serum ++ Retr. none	Serum +++ Retr. incomp.	Serum ++++ Retr. comp.	
Cystine 200 mg. Cystine 150 mg. Blood 5 cc.	+	Serum +++ Retr. none	Serum ++++ Retr. comp.	Serum ++++ Retr. comp.	

Results: 150 mg. of cystine proved to be the minimum amount which antagonized the antiretractile property of the cystine constant with restoration of complete clot retraction within three hours.

On June 9, 1939, 5 cc. of blood was added to each of two test tubes, one of which contained 300 mg. of methionine, while the other served as the control. The clot in the latter did not retract in twenty-four hours, while the clot in the former retracted completely within three hours. At this time 8 Gm. of cystine in milk was administered daily during her stay at the hospital. Bleeding from gums and vagina steadily diminished, and on July 13, all bleeding ceased. Therapy was discontinued, and on July 19, bleeding from gums and vagina recurred and new ecchymotic areas were noted. Cystine therapy was resumed and the bleeding

September 16, 1939, she was free from all bleeding though an occasional pin point ooze from an isolated area of the gum appeared after brushing teeth. Hematologic examination revealed: platelets, 100,000; complete clot retraction within four hours; tourniquet test, negative; bleeding time, ten minutes; coagulation time, three and one-half minutes; hemoglobin, 9.4 Gm.; red blood count, 3,400,000. The patient was discharged with instructions to continue cystine therapy while under observation. On July 15, 1940, patient enjoyed perfect health and was free of any bleeding tendency. During administration of cystine, the

January 19, 1940, at which time platelets dropped to 10,000; clot retraction prolonged to two and one-half hours; bleeding time, six minutes; and nasal bleeding and bleeding from gums recurred. Administration of cystine was resumed, and on February 6, platelets rose to 90,000; clot retraction, one hour and fifteen minutes; and nasal bleeding and bleeding from gums ceased. At this time 5 Gm. of cystine in capsules was administered daily as a substitute for cystine until March 4, 1940. The

were given. On follow-up it was learned that she refused medication as she was free from active bleeding or spontaneous subcutaneous hemorrhage until the beginning of July, at which time slight nasal bleeding appeared.

CASE IV. (R. C.) female, age 38, was admitted to Beth-El Hospital March 18, 1940, complaining of profuse vaginal bleeding and "blood spots" over the body and in the mouth. For the past six years the patient had noticed "black and blue" marks over various portions

TABLE V

THE EVALUATION OF INCREASING AMOUNTS OF TYROSINE AS ANTAGONISTS TO THE CYSTEINE CONSTANT WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Normal control Blood 5 cc.	4	Serum ++ Retr. incomp.	Serum +++ Retr. comp.	Serum ++++ Retr. comp.	
Cystine 150 mg. Blood 5 cc.	5	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none	Serum - Retr. none
Tyrosine 50 mg. Cystine 150 mg. Blood 5 cc.	4	Serum + Retr. none	Serum + Retr. none	Serum + Retr. none	Serum + Retr. none
Tyrosine 100 mg. Cystine 150 mg. Blood 5 cc.	4	Serum + Retr. none	Serum + Retr. none	Serum + Retr. none	Serum ++ Retr. none
Tyrosine 150 mg. Cystine 150 mg. Blood 5 cc.	4	Serum ++ Retr. none	Serum ++ Retr. none	Serum ++ Retr. none	Serum ++ Retr. none
Tyrosine 200 mg. Cystine 150 mg. Blood 5 cc.	4	Serum +++ Retr. incomp.	Serum +++ Retr. incomp.	Serum +++ Retr. incomp.	Serum +++ Retr. incomp.

Results: Tyrosine exerts no significant antagonism to the cysteine constant with regard to clot retraction.

platelets dropped to 10,000 and the clot failed to retract in twenty-four hours, the nose bleeds recurred and many ecchymotic areas appeared over the body. Beginning March 4, 1940, 8 Gm. of methionine in milk was administered daily and on March 18, the platelets rose to 110,000; clot retraction, one hour and fifteen minutes; nose bleeds ceased, and all ecchymotic areas had disappeared. On March 25, patient expressed a desire to go home and she was advised to continue the medication on a maintenance dose of 5 Gm. daily. During the administration of cystine, cysteine and methionine, respectively, no transfusions or other drugs

of her body and suffered frequent nose bleeds. There was no history of ingestion of drugs or acute infection immediately preceding present episode. Vaginal examination and menstrual history presented no significant departure from the normal.

Laboratory Data: Platelets, 50,000; no clot retraction in twenty-four hours; tourniquet test, positive; coagulation time, five minutes; bleeding time, twelve and one-half minutes; iodine number, 57.7; hemoglobin, 6.5 Gm.; red blood count, 2,500,000; white blood count, 6,800; polynuclear leukocytes, 65; nonsegmented, 2; eosinophiles, 2; lymphocytes, 23;

fifteen minutes, followed by semistupor, loss of speech and paralysis of right upper and lower extremities. Bleeding from gums was profuse, and catheterized specimen of urine contained much blood. Therapy for control of bleeding following splenectomy consisted of numerous transfusions, proeholon, vitamin K, thiamin, letron and parathyroid. On the day after the convulsions, the patient was semistuporous, but could be roused to take fluids. On May 19, 10 cc. of venous blood was withdrawn. To 5 cc. of

posteriorly, originating in the retina and invading the vitreous humor. Neurological examination revealed a flaccid paralysis of right lower extremity as a result of bleeding into subarachnoid space (hematomyelia). The ingestion of methionine was not followed by any untoward gastric effects.

The subsequent clinical picture was one of progressive improvement. On June 3, platelet count was 100,000; red blood count, 3,870,000; hemoglobin, 10.5 Gm. On June 7, the patient

TABLE VII

THE EFFECTS OF 150 MG. OF METHIONINE, CYSTINE, GLYCINE AND TYROSINE, RESPECTIVELY, UPON 5 CC. OF BLOOD FROM CASE L. E., ESSENTIAL THROMBOCYTOPENIC PURPURA, WITH REGARD TO CLOT RETRACTION

	Coagulation Time, Min.	Clot Retraction			
		1 Hour	2 Hours	3 Hours	24 Hours
Purpura bld. 5 cc.	3	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none
Purpura bld. 5 cc. Methionine 150 mg.	3	Serum + Retr. none	Serum ++ Retr. none	Serum +++ Retr. comp.	
Purpura bld. 5 cc. Cystine 150 mg.	3	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. comp.	
Purpura bld. 5 cc. Glycine 150 mg.	3	Serum — Retr. none	Serum + Retr. none	Serum +++ Retr. incomp.	6 hrs. Serum +++ Retr. comp.
Purpura bld. 5 cc. Tyrosine 150 mg.	3	Serum — Retr. none	Serum — Retr. none	Serum — Retr. none	24 hrs. Serum — Retr. none

blood, 150 mg. of methionine was added and clot retraction was complete in two hours, whereas the remaining 5 cc. of blood which served as a control did not retract in twenty-four hours. Thereafter, the patient was given 8 Gm. of methionine in milk daily for four weeks. On May 22, the patient regained consciousness, seemed to understand when spoken to, but could not speak. Platelets had risen to 80,000, and on May 27, to 100,000. Urine was devoid of blood and bleeding from gums was markedly diminished. She spoke rationally and moved her right upper extremity about in normal fashion, though the paralysis of the lower extremity persisted. Eye ground examination at this time revealed a massive hemorrhage

was discharged with instructions to continue methionine therapy. All ecchymotic areas had disappeared and vaginal bleeding had ceased completely. Urine was free of blood. The patient's morale was excellent and she was able to move the toes and ankle of right foot. Vision was still impaired though much improved. On June 22, platelets, 30,000; clot retraction complete in one and one-half hours; tourniquet test, negative; bleeding time one and one-half minutes; coagulation time, eight minutes; hemoglobin 75 per cent; red blood count, 4,800,000; white blood count, 10,600; polynuclear leukocytes 37; lymphocytes, 58; monocytes, 5. On July 17, when last seen, the patient was able to move her right lower ex-

tremity without effort and there was no evidence of bleeding and hematological report was as follows: hemoglobin, 80 per cent; red blood cells, 4,100,000; platelets, 160,000; clot retraction complete in one hour and ten minutes; tourniquet test, negative. Transfusions and all previous therapy were eliminated during treatment with methionine.

examination did not reveal any significant departure from the normal. Eye ground examination revealed many pin-point hemorrhages in the retina.

Laboratory Data: Platelets, none seen; no clot retraction in twenty-four hours; tourniquet test, positive; coagulation time, four minutes; bleeding time, twelve and one-half minutes;

TABLE VIII

THE COMPILATION OF THE MINIMUM AMOUNTS OF METHIONINE, CYSTINE, GLYCINE AND TYROSINE, RESPECTIVELY, REQUIRED TO RESTORE COMPLETE CLOT RETRACTION TO WITHIN THE NORMAL LIMITS WHEN ADDED TO 5 CC. OF BLOOD FROM EACH OF FIVE CASES OF ESSENTIAL THROMBOCYTOPENIC PURPURA

Essential Thrombo-Cytopenic Purpura Cases	Purpura Bld. 5 cc.	Clot Retraction Time			
		Methionine	Cystine	Glycine	Tyrosine
B. B. 8 13 36 Platelets 68,000 Bleeding time 8 min. Active bleeding	Retr. none 24 hrs.	150 mg. Retr. comp. 3 hrs.	150 mg. Retr. comp. 3 hrs.	150 mg. Retr. comp. 6 hrs.	150 mg. Retr. incomp. 24 hrs.
W. F. 6 9 30 Post splenectomy Platelets 60,000 Bleeding time 12½ min. Active bleeding	Retr. none 24 hrs.	300 mg. Retr. comp. 3 hrs.	300 mg. Retr. comp. 3 hrs.	300 mg. Retr. comp. 6 hrs.	300 mg. Retr. none 24 hrs.
L. E. 1 15 40 Platelets none Bleeding time 11 min. Active bleeding	Retr. none 24 hrs.	150 mg. Retr. comp. 3 hrs.	150 mg. Retr. comp. 3 hrs.	150 mg. Retr. comp. 6 hrs.	150 mg. Retr. none 24 hrs.
R. C. 5 19 40 Post splenectomy Platelets 5,000 Bleeding time 15 min. Active bleeding	Retr. none 24 hrs.	300 mg. Retr. comp. 4 hrs.	300 mg. Retr. comp. 4 hrs.	300 mg. Retr. comp. 8 hrs.	300 mg. Retr. none 24 hrs.
F. L. 4 27 40 Platelets none Bleeding time 12½ min. Active bleeding	Retr. none 24 hrs.	200 mg. Retr. comp. 2 hrs.	200 mg. Retr. comp. 3 hrs.	200 mg. Retr. comp. 6 hrs.	200 mg. Retr. none 24 hrs.

CASE V. (F. L.) female, age 60, was admitted to Beth Moses Hospital April 19, 1940, complaining of bleeding from gums and per vaginum and "blood spots" over the body for past two weeks. Six years ago patient noted some "black and blue" marks over thigh which disappeared soon after with no recurrence until present episode. There was no history of ingestion of drugs or acute inflammatory condition previous to onset of present complaints. Menopause was established at age of 50, and vaginal

iodine number, 55.3; prothrombin time, ascorbic acid and fragility test within the normal limits; hemoglobin, 78 per cent; red blood count, 3,500,000; white blood count, 11,500; polynuclear leukocytes, 58 per cent; lymphocytes, 35; mononuclears, 3; eosinophiles, 4; sternal puncture: polynuclear leukocytes (segmented), 48.5; polynuclear leukocytes (non-segmented), 30; myelocytes, 9; myeloblasts, 2; eosinophiles, 4; eosinophile myelocytes, 1; basophiles, 1; megakaryocytes, 1; lympho-

cytes, 35; nucleated red blood cells, 80/00 white blood cells. Despite the administration of ascorbic acid, calcium gluconate and transfusion, the bleeding from gums, nose and vagina continued and progressively increased in intensity, reaching alarming proportions. The whole body was actually covered with petechiae and extensive ecchymosis, including mouth and pharynx. On April 27, 1940, 5 cc. of blood was added to each of two test tubes, one of which contained 200 mg. of methionine, while the other served as the control. The clot in the latter did not retract in twenty-four hours, while the clot in the former retracted in two hours. At this time, 8 Gm. of methionine in milk was administered daily until May 27, 1940, date of discharge. On May 6, bleeding from vagina completely ceased and only an occasional local oozing from an isolated area of gum was noted. Platelet count was 20,000, and clot retraction started in one and one-half hours, and was complete in three hours. On May 20, all bleeding had ceased and previous ecchymotic areas had practically disappeared, platelet count, 30,000; clot retraction complete in one hour and ten minutes. On May 27, there was no evidence of any bleeding and body was free of any petechiae and ecchymotic areas. On June 4, follow-up at home found patient enjoying good health and free of any bleeding tendency. Blood examination revealed: platelets, 40,000; coagulation time, two minutes; bleeding time, three minutes; clot retraction complete in one hour. On July 22, the patient came in for check up and showed no evidence of any bleeding, gained weight and otherwise felt perfectly well. Hematological examination revealed: hemoglobin, 84 per cent; red blood count, 5,300,000; platelets, 120,000; clot retraction complete in one hour and thirty minutes.

DISCUSSION

Many interesting and suggestive observations with regard to the rôle of the liver in clot retraction as applied to essential thrombocytopenic purpura have taken form in the light of accumulated experimental data. Desaturation of fatty acids, a function attributed to the liver, is definitely impaired in this disease as indicated by the low iodine numbers in seven cases of essential thrombocytopenic purpura. It has been shown in the text that cysteine

abolishes clot retraction in vitro for more than twenty-four hours. Cysteine is essential in the formation of taurocholic acid by the liver. It is believed that cysteine, an intermediary in cystine degradation, first undergoes conjugation with cholic acid in the body, and the conjugated product is then oxidized to taurocholic acid. Hence impairment of liver function may seriously impede conjugation of cysteine with cholic acid and the further oxidation of the conjugated product to taurocholic acid, with the resultant adverse effects of cysteine upon clot retraction. Cysteine is an -SH compound and acts directly on thrombin³ by reducing the -S-S- linkages in the protein of the thrombin when it is formed from prothrombin. The enzyme thrombin is only active when most of the sulphur is in the -S-S- form. Thus cysteine disturbs the consummation of the physiologic mechanism of blood clotting with resultant inadequate clot retraction. Alteration of clotting time is directly dependent upon the amount of thrombin inactivated by cysteine.

Clinically, the marked disparity with regard to results obtained by the administration of cystine and methionine, respectively, in the control of bleeding and restoration of clot retraction in essential thrombocytopenic purpura, points clearly to a disturbance in the metabolism and utilization of cystine in this disease. When an adequate amount of cystine and methionine, respectively, were added to blood from five cases of essential thrombocytopenic purpura, clot retraction was restored to the normal levels by both cystine and methionine. However, when an adequate amount of cystine was administered to patients, B. B. and W. F., cessation of bleeding and the restoration of clot retraction were tardy and variable, while the administration of methionine to patients, F. L. and L. E., was attended by a rapid and dramatic cessation of bleeding and restoration of normal clot retraction. The administration of cystine to patient, L. E., was not reflected by any noticeable changes

in the status of the bleeding tendency or clot retraction. When methionine was substituted for cystine in this case, a rapid cessation of bleeding and restoration of clot retraction took place shortly thereafter. Obviously, the marked improvement in the clinical course and the rapid approach to normal clot retraction by the substitution of methionine for cystine gave added testimony to the assumption that utilization of cystine is impaired in this disease. The discovery by Jackson and Block⁴ that methionine is capable of stimulating growth of rats subsisting on a basal diet poor in cystine conveys unusual significance to the effectiveness of methionine as a substitute for cystine with regard to control of bleeding and restoration of clot retraction in essential thrombocytopenic purpura.

It is often pointed out that removal of the spleen in essential thrombocytopenic purpura is attended by an immediate rise in platelets, cessation of bleeding and a return to normal clot retraction. These gratifying results do not always follow splenectomy as attested by the continuous and alarming bleeding, low platelet count and complete absence of clot retraction in patients, W. F. and R. C., after splenectomy. Many similar cases have been reported in the literature. In the light of these untoward results it cannot be said that the spleen is essentially the offending organ in this disease. On the other hand, the spleen, in performing its function as a "graveyard" rather than as a "slaughter house" for biochemically disqualified platelets, may become a burden and a liability, thus preventing the return of the liver to its normal rôle in the physiologic process of blood clotting and clot retraction. It stands to reason that the removal of the spleen would relieve the liver from fighting on two fronts, and allow it to recover the vital functions necessary for normal blood clotting and

clot retraction. In the very acute stage of the disease, removal of the spleen may not offer sufficient relief to the liver, resulting in the continuation of the bleeding tendency, absence of clot retraction and notably low platelet count. It therefore seems logical that adequate means instituted for the control of the bleeding tendency predicated on a physiologic basis is indicated preparatory to splenectomy. The oral administration of methionine in essential thrombocytopenic purpura fulfills these requirements to the fullest extent and with most gratifying results.

SUMMARY

The influence of amino acids in the physiologic process of clot retraction and evidence pointing to impaired liver function in essential thrombocytopenic purpura have been presented. Methionine is more effective than cystine in controlling spontaneous bleeding and in restoring clot retraction in the acute form of essential thrombocytopenic purpura. The beneficial effects of the oral administration of methionine with regard to control of spontaneous bleeding and restoration of clot retraction have been definitely established and are of inestimable value in the management of both the acute and chronic stages of the disease. The use of methionine in this disease lends comforting support to the surgeon, preparatory to splenectomy.

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A REVIEW OF MALIGNANT MELANOMA OF THE MOUTH*

REPORT OF A CASE

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A REVIEW of the literature reveals that malignant melanoma of the mouth is rather uncommon. Since Weber (1859) reported the first tumor of this type on the palate, only fifty-four cases of this tumor in the mouth have been reported in the literature. Not included within the scope of this paper are two cases of melanoma of the tonsil (Morizad, 1923; Schibler, 1934) and five cases of melanoma of the pharynx (Seidel, 1905; Brünner, 1938; Hünermann, Kaufmann, Kretschmann—quoted by Brünner). An analysis of fifty-four cases of malignant melanoma of the mouth collected from the literature has been made from which several important conclusions may be drawn.

The neoplasm occurred in the male in thirty-five cases and in the female in fourteen. Thus, although the number of reported cases is small, it seems that melanoma, like carcinoma, is more common in men. Unlike sarcoma, which is most frequent in youth, malignant melanoma is a disease of middle age. The average age of the patients was 46 years. The oldest was 84 and the youngest 2 months. Individuals over 40 years of age comprised 68 per cent of the cases and only four under 25 years of age were reported. Krompecher (1918) has noted a remarkable case of congenital melanoma in an infant of 2 months. The figures seem to indicate that the neoplasm is more common in the white than in the colored races. Of the fifty-four cases reported, only six were in colored persons (viz. 4 Orientals and 2 Negroes). The comparative rarity of melanoma in the colored races has been noted by Bishop (1932) and other authors.

An analysis of the regional distribution

of the tumor in the mouth is interesting. In thirty-six patients it originated on the hard or soft palate. In fifteen it occurred on the alveolar process of the maxilla. It was reported once on the tongue, the mandible, the lower lip and the cheek, respectively. Since almost 93 per cent of the lesions were situated on the palate or superior alveolar process, the special predilection of the tumor for the maxilla is apparent and has given rise to much speculation.

The lapse of time between discovery of the presence of the neoplasm by the patient and application for medical care varied greatly. The longest period was ten years and the shortest one month. In 70 per cent of the cases the interval was one year or less. The time factor is of vital importance when one considers the tendency of this tumor to metastasize early. Excluding the cases in which the presence or absence of cervical metastases was not mentioned, 55 per cent of the patients had enlarged cervical glands when first examined and 77 per cent developed cervical metastases during the course of the disease. These figures support the hypothesis that malignant melanoma of the mouth tends to metastasize primarily through lymphatic channels and that any method of treatment should be planned to take cognizance of this tendency. In eleven of the cases, pigmented areas had been observed in the mouth prior to development of the neoplasm. This is significant and will be considered more fully.

ETIOLOGY

Trauma has been suggested as a causal agent in melanoma of the mouth, for

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example, chronic irritation of the gingivae caused by malocclusion (Treves, 1886-1887) or by a wound of the palate (Roy, 1907). Levi (1895) claimed that chronic infection might be a predisposing factor. According to others, the complicated embryologic development of the mouth, partly from ectoderm and partly from endoderm, results in a region where developmental defects are likely to occur or cell rests to remain and, under some stimulus, to undergo proliferative neoplastic change. In Krompecher's case of congenital melanoma in a child only 2 months old, its origin was attributed to the epithelial debris of a tooth which was involved in the tumor.

Reiche (1924) has shown that about 50 per cent of Negroes, Indians, Arabs and Chinese normally have pigmented areas in their oral mucosa and that the same condition is not uncommon among Caucasians. The pigmented areas were most frequently found in men, especially in those having dark hair. Since many mammals, e.g., the horse, cow, dog, deer, fox, lemur and some monkeys (*Lagothrix lagotricha*) often have deeply pigmented palates, a phylogenetic basis for the presence of pigmented areas in the human mouth and particularly on the superior alveolar ridge and palate is suggested. In the cases reported only one-fifth of the patients had noticed a pigmented area on the oral mucosa prior to the development of the tumor. However, in the other cases it may have been present but insignificant in size, or inaccessibly located, or the patient may have been unobservant.

As already noted, practically 93 per cent of melanomas of the mouth originate on the superior alveolar ridge or palate. It seems probable that the tendency of the neoplasm to occur on the maxilla may be attributed to the complicated embryologic development of the latter and to the inclusion in it of cells which are capable of producing melanin, and that later in life some stimulus may cause these cells to undergo neoplastic proliferation.

SYMPTOMS

The majority of patients present themselves for examination complaining of the presence of a swelling in the mouth which has been detected by the tongue. In many of the cases described this was the only symptom. In a few, the primary lesion had not been detected at all and the swelling caused by metastases in the cervical region was the reason for which the person sought medical advice. Enlargement of the cervical glands may sometimes exist without being observed by the patient. Hemorrhage is a frequent symptom because the neoplasm is usually soft and vascular and may be traumatized during mastication by the food or the teeth. Sometimes the patient squeezes the tumor or endeavors to remove it by some means and thus causes it to bleed. Ulceration is prone to develop following trauma. If the tumor is large, exposed to frequent trauma, or if an inflammatory reaction occurs as a result of ulceration, pain is likely to be complained of. Loosening of the teeth is a symptom of advanced invasion of the alveolar process of the jaw by the neoplasm, and irritation of the dental nerves in some cases may cause severe neuralgia of the branches of the fifth nerve.

Gussenbauer (1886), Martens (1897), Roy (1907) and Baxter (1939) have reported cases in which the maxilla had been invaded by the tumor. Interference with phonation, dysphagia and dyspnea appear only if the tumor is large or is situated in a region likely to disturb functioning of the organs. Trismus is also a late manifestation and occurs only if the growth is large enough to interfere with the movements of the mandible or cause reflex spasm of the muscles of mastication.

PATHOLOGY

According to various authors this neoplasm has been thought to originate from epithelium, young connective tissue, lymphatics, endothelium or perithelium of blood vessels, sheaths of nerve fibers and chromatophores. In view of the fact that

controversy still exists as to the origin of the cells of the neoplasm, perhaps it is advisable to designate it by the term "malignant melanoma," pending further investigation.

Grossly, the tumor is usually dark brown or black in color, soft and vascular. The surface is often nodular or warty, and the base may be sessile or pedunculated. These characteristics render the term "black-berry tumor" rather an apt description of the lesion. It may grow slowly or rapidly, or a sudden rapid increase in size may take place in a previously slowly growing tumor. Melanotic tumors in the mouth usually metastasize primarily through lymphatic channels to the regional lymph glands, unlike melanomas of the eye, which frequently metastasize through the blood stream with widespread dissemination. The metastases of a deeply pigmented tumor may show no trace of pigment (Ebermann, 1896; Seybold, 1899; Seidel, 1905), and the converse is true in that a primary tumor with little or no pigment may give rise to deeply pigmented metastases. Also, the local recurrence of a pigmented tumor may be pigment-free (Liebold, 1901; Schibler, 1934).

Microscopically, the neoplasm may show atrophy and thinning of the overlying stratified squamous epithelium. Beneath this the tumor cells may be large, polyhedral and arranged in an alveolar fashion with a fine stroma which gives the growth a carcinomatous appearance. Frequently, the cells are oval or spindle-shaped and the arrangement sarcomatous or fibrosarcomatous in type. Pigmentation is marked in most cases but is unevenly distributed so that in one part of the tumor the cells may be filled with pigment and in another part they may contain none. If the pigment cells become overloaded, they may break down and liberate the melanin, which is absorbed by phagocytic histiocytes. A secondary purulent inflammatory reaction may occur if ulceration develops. Grossly, the tumor may appear to be almost black, but on microscopic examination the pigmentation is observed to be caused by extracellular

clumps or intracellular granules of yellowish or brownish pigment. The degree of pigmentation bears no relation to the malignancy of the tumor.

DIAGNOSIS

The most distinctive feature of this neoplasm is its color which, as already mentioned, is usually dark brown or black, and which leaves scarcely any doubt as to its identity. The surface is commonly nodular or wart-like, and the tumor usually grows rapidly. The cervical glands may be enlarged, which fact provides further support for the diagnosis. If the lesion is in an early stage and doubt exists as to the nature of the growth, a frozen section should be made, with previous preparation for the carrying out of a radical operation if the microscopic examination reveals a malignant melanoma.

Certain other conditions may be considered in differential diagnosis, pigmentation by bismuth or lead, for example. The former condition is not uncommon, and large, solidly pigmented plaques may be present on the oral mucosa when bismuth has been used intensively as a specific therapeutic agent. New and Hensel (1921) have reported a case in which a fragment of lead from a pencil was embedded in the palatal tissues and simulated a melanotic tumor. Again, certain blood dyscrasias may cause small hemorrhagic areas in the oral submucosa, which may be mistaken for this neoplasm.

TREATMENT

As in the case of all malignant neoplasms, early diagnosis and treatment are of paramount importance. Delay on the part of the patient in seeking medical advice or on the part of the doctor in diagnosis is often recorded. Only by early and adequate treatment may the high rate of mortality from this neoplasm be reduced. Once the tumor has reached a fair size in the mouth, in the majority of cases the adjacent lymphatics and regional lymph glands will be harboring metastatic tumor cells which

may not cause detectable enlargement of the lymph glands for months.

As is usual when dealing with a disease which is refractory to treatment, many methods of therapy have been used empirically in the treatment of malignant melanoma, some of which will be enumerated. Injections of Coley's fluid have not been found efficacious. P. W. Brown (1933) used colloidal lead phosphate in a case of malignant melanoma with large metastases in the groin, which had failed to respond to irradiation. Complete disappearance of all evidence of the disease resulted and the patient survived for over four years. However, Meland and Lindberg (1936) have tried this method of treatment recently in two advanced cases with failure in both. The effect of repeated injections of cobra venom and anavenin on spontaneous melanotic tumors in the rabbit and the horse has been reported by Grasset and des Ligneris (1934). The neurotoxic action of the venom suggested a study of its action on melanoma. At first there was marked regression in the size of the tumors, but unfortunately this was not maintained, probably owing to the development of antibodies in response to the antigen injected. Thus it seems unlikely that this method would be of therapeutic value in man.

Irradiation. According to Adair (1936) only 2.5 per cent of malignant melanomas respond to irradiation, so that neither radium nor roentgentherapy is advisable as a major agent in treatment. Furthermore, rapid generalization of a melanotic tumor may occur after irradiation. Recently Wigby and Metz (1939) have tried irradiation of the pituitary gland in a case of malignant melanoma with generalized skin metastases, since they assumed that there might be some intimate connection between the secretion of the intermediate lobe and the abnormal growth and reproduction of melanin-containing cells, and they obtained marked regression of the nodules. However, in four subsequent cases with glandular metastases there was not the slightest response to this form of therapy and all the

patients died. In general, the futility of irradiation therapy as a sole or major method of treatment of malignant melanoma of the mouth is shown by the results in those cases in which it was used.

Surgery. More hope of cure is offered by surgery than by any other method in malignant melanoma of the mouth. The fact must not be overlooked that perhaps some of the sinister reputation of malignant melanoma may be attributed less to the extreme malignancy of the disease than to haphazard and unscientific methods of operative treatment. If the lesion is small and is situated on the maxilla, where these tumors in the mouth predominantly occur, electrocautery is the best means of destroying it. The soft tissues should be cauterized widely beyond the margins of the growth and the cauterization should extend down to and include part of the bone which will sequestrate. If teeth are adjacent to or involved in the neoplasm, they should be extracted to afford better access. If the neoplasm is large, part or the whole of the maxilla may have to be destroyed by electrocautery. In the case of melanotic tumors situated on the mucous membrane of the cheek, lip or soft palate, wide excision of the lesion by electrocautery should be performed.

Unfortunately, a block dissection of the neck was performed in only a few cases. Before considering the indications for a block dissection of the neck, the lymphatic drainage of the hard and soft palate should be recalled. According to Rouvière (1932), the lymphatic plexus of this region collects into vessels which drain in three different directions: an anterior group of vessels, present in 50 per cent, which leads to the submaxillary lymph glands after first passing through the supramandibular glands, which are situated on the outer surface of the mandible in proximity to the facial vessels; a middle group, which is constant and empties into the superior deep cervical lymphatic glands, and a posterior group, present in 60 per cent, which drains into the retropharyngeal lymph glands. The lymph-

phatic plexus of the gingival mucosa on the external surface of the alveolar process drains into the submaxillary lymph glands. The middle group of lymphatic vessels usually anastomoses with those of the opposite side, while the anterior and posterior groups cross the midline in only about 50 per cent.

If the neoplasm is situated on the anterior portion of the hard palate or alveolar ridge, metastases would probably develop in the supramandibular, submaxillary or superior deep cervical glands; whereas, if the tumor originated on the soft palate, metastases would probably appear in the retropharyngeal lymph glands, which are almost inaccessible to surgical intervention. If a block dissection is performed, the excision should be carried well above the inferior border of the mandible to include the supramandibular glands.

While the complicated anatomic distribution of the lymphatic drainage of the palate may raise doubts as to the advisability of performing a block dissection of the neck, in general if the neoplasm is large an extensive and careful dissection should be carried out on one or both sides, as indicated by the site of the tumor, whether the cervical lymph glands are palpable or not. On the other hand, if the neoplasm is small, the cervical glands are not palpable and the patient can be observed at regular intervals, it may be justifiable to postpone the neck dissection until the presence of cervical metastases is detected. The presence of cervical metastases does not contraindicate radical operation, as is shown by a case of Dr. J. B. Brown, reported as follows:

"Wide excision with electro-cautery of a malignant melanoma of the skin in the temporal region was followed in a few months by the development of a cervical metastasis as large as a small egg. An extensive block dissection of the neck was performed. A short time later a recurrence developed in the skin of the neck. Wide excision of this lesion was carried out and the patient has remained free from any sign of the disease for 5 years."

Obviously no surgical treatment should

be attempted until the presence of pulmonary or visceral metastases has been disproved as far as possible by appropriate examinations.

PROGNOSIS

Admittedly, melanotic tumors of the mouth, like such tumors of the rectum, offer a very poor prognosis. This is substantiated by the fact that the usual duration of life after the true nature of the lesion was recognized was from one to two years in the cases reported. Gussenbauer's case, it is true, showed a recurrence after four years, and Weber's patient was free from recurrence six years after operation. However, these were exceptions. The only hope of improvement in the results lies in early recognition, wide destruction of the primary lesion, preferably by electro-cautery and block dissection of the cervical lymph glands which drain the affected area.

CASE REPORT

The following case of malignant melanoma of the mouth, which was attended in the Oral and Plastic Surgery Department of the Cook County Hospital, Chicago, is reported with the permission of Dr. W. H. G. Logan, who treated the case.

M. S., a white male, aged 42, was admitted March 18, 1938. The patient stated that nine months previously he had noticed some small red papules on the mucosa above the upper central incisors, which contained a small amount of clear fluid. He squeezed these frequently to release the contained fluid, but they quickly reformed. A month later the papules became larger, bluish-black in color and lobulated. Since then the tumor had grown steadily in size. Shortly after he had observed the tumor on the labial mucosa, a similar lesion developed on the lingual side of the upper central teeth, probably by extension through the interdental embrasures via the interdental papillae. One month before admission a pea-sized lump developed behind the incisor teeth. It was reddish at first and then became bluish-black in color. It was painful, probably owing to trauma caused by the teeth during mastication.

tion. A few days later, when the patient was squeezing it, a piece of the tumor about the size of a half pea was dislodged. It was black and felt "rubbery."

Physical Examination. Examination of the ears, nose and throat revealed nothing remarkable. The fundi were normal. The cervical, axillary and inguinal glands were not palpable.



FIG. 1. Primary malignant melanoma of the mouth in a white male, aged 42 years. Duration nine months.

Local Condition. A bluish-black mass, $2 \times 1.5 \times 0.5$ cm., firm in consistency, with a pebbled or lobulated surface, was situated on the mucous membrane above the upper incisor teeth. (Fig. 1.) A few small, discrete, black pigmented areas were observed on the

A roentgenogram of the chest showed old calcified lesions in both apices. The cardiovascular system and the abdomen appeared normal. A few brownish moles were present on the integument but none showed any evidence of neoplastic change.



FIG. 2. Same case several months after removal of the neoplasm by electrocoagulation, showing separation of a sequestrum of part of the maxilla.

mucosa a few millimeters from the main tumor. On the lingual surface of the incisor teeth there was an extension of the tumor as a flat, black pigmented area on the palate about 1×1.5 cm. An x-ray examination of the maxilla showed that it had not been invaded by neoplasm.



FIG. 3. Same case six months postoperatively, showing regeneration of the oral mucosa.

Laboratory Tests. The blood findings were within physiologic limits and the Wassermann reaction was negative. There was no melanuria and the urine was essentially negative. X-ray examination of the stomach and duodenum showed nothing unusual and proctoscopic examination revealed no evidence of a melanoma in the rectum or sigmoid colon.

Biopsy. Microscopic examination showed a polypoid structure with an overlying stratified squamous epithelium which for the most

part was rather thinned and atrophied. (Fig. 4.) Beneath this was a solid mass of closely packed, fusiform-shaped cells with large,

of the mouth reported in the literature are analyzed. The neoplasm occurred in males more commonly than in females. In the

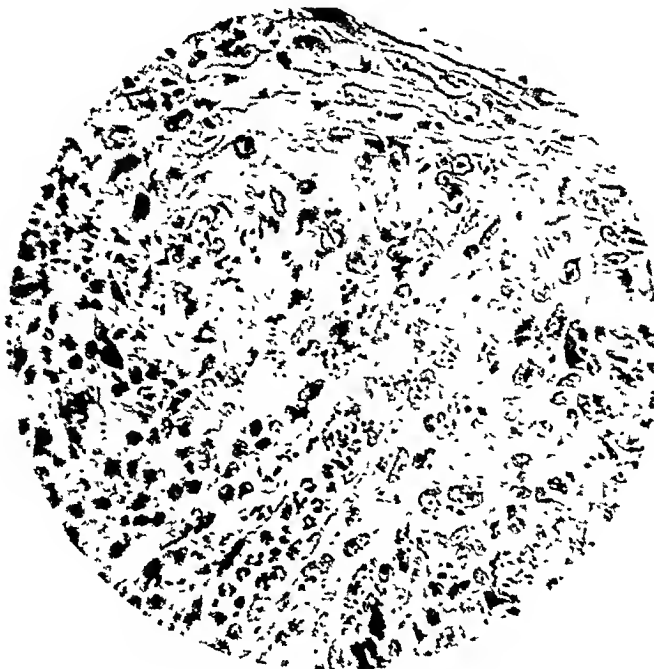


FIG. 4. Photomicrograph of the neoplasm (same case). It is composed of large melanoblastic tumor cells of immature character with fine granular brownish pigment in the cytoplasm. There are also large collections of brownish pigment in phagocytic cells between the tumor elements.

elliptical nuclei and poorly defined cytoplasmic boundaries. Many of the cells showed the presence of fine, granular, brownish pigment in the cytoplasm. There were also large collections of brownish pigment in phagocytic cells between the tumor elements.

Diagnosis. Melanocarcinoma.

Treatment was begun on April 12, 1938. After extraction of the upper incisor and bicuspid teeth to afford free access to the lesion, the entire mucous membrane including the tumor was destroyed by electrocautery as far back as the molar teeth. Then the bared bone of the maxilla was thoroughly cauterized. As a result, a sequestrum involving about half the thickness of the bone separated after several months. (Fig. 2.) The palate gradually became covered with epithelium (Fig. 3) and eighteen months postoperatively there was no evidence of recurrence in the mouth, the cervical lymph glands or the lungs, and the patient was in good health and able to carry on his usual work.

SUMMARY

Fifty-four cases of malignant melanoma

majority of cases (68 per cent) the patient was over 40 years of age. The youngest was a baby of 2 months and the oldest a woman of 84. Most of the cases occurred in Caucasians. Only six in the colored races were reported.

The complicated embryologic development of the maxilla, which is formed partly from ectoderm and partly from endoderm with inclusion of cells in the mucosa capable of forming melanin, has been advanced as the reason for the extraordinary predilection of the neoplasm for the maxilla (93 per cent of cases of melanoma of the mouth). Not infrequently the neoplasm developed from a pigmented area which had been present on the palate for many years.

The most common sign is the presence of a rapidly growing "blackberry tumor" in the mouth. Hemorrhage, pain, loosening of the teeth, cervical metastases, dysphagia, dyspnea, interference with phonation and trismus may occur. If doubt exists as to

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the diagnosis, a frozen section may be made with the intention of performing a radical operation if a malignant melanoma is present.

The treatment of choice is surgery. Wide removal of the primary growth by electrocautery may be performed, followed by block dissection of the cervical lymph glands into which the area involved drains. The possible presence of pulmonary or visceral metastases should be considered before surgical treatment is attempted.

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SPONTANEOUS INTERNAL BILIARY FISTULA*

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INCIDENCE

SPONTANEOUS internal biliary fistulae, while not surgical curiosities, are very uncommon. Among the 15,677 operative cases on Surgical Section A in the Hospital of the University of Pennsylvania from September 1, 1922, to September 1, 1939, the condition has been encountered five times. With the exception of one instance the diagnosis was made at the operating table. In 1925, Judd and Burden¹ reported 153 cases of spontaneous internal biliary fistula operated upon at the Mayo Clinic. The condition was diagnosed pre-operatively in only two instances. Only seven cases appeared in 6,000 autopsies at the Cook County Hospital according to reports of Davison and Aries² in 1938. In none of these was an ante mortem diagnosis made, the true state of affairs being recorded incidentally at autopsy. Roth, Schroeder and Schloth found forty-three cases in 11,000 autopsies. Bernhard³ reported the finding of 109 internal biliary fistulae in 6,263 cases of surgical intervention upon the biliary passages, with a percentage incidence of 1.8.

It is the purpose of this brief discussion to consider the pathogenesis, diagnostic features and importance, and in the light of these facts present for consideration the cases appearing on our service in this clinic. The presence of a spontaneous internal biliary fistula according to Judd and Burden¹ is merely another example of nature's attempt at self healing, the fistula being a complication of a pre-existent pathological process.

TYPES

A perusal of the literature in this field serves to impress upon one the multiplicity

of conditions which may produce spontaneous internal biliary fistula. The recorded types include: (1) Communications between the biliary tree and the esophagus, stomach, duodenum, jejunum, ileum, appendix and colon; (2) communications between the biliary tree and the bronchi or pleura; (3) communications between the biliary tree and the urinary tract, umbilicus, fallopian tubes, uterus, vagina, ovarian cysts and pericardium; and (4) various complex combinations involving more than two viscera, i.e., cholecysts—duodenal colic fistulae.

Dean⁵ includes reported cases of communications between the biliary tract and the portal vein and hepatic artery in his recent discussion of the subject. The term, "biliary tree," has been used to include the liver, gallbladder and the extra hepatic bile duct.

The relative frequency of the various types is well illustrated by the series of Judd and Burden¹ at the Mayo Clinic. Of their 153 cases, 117 communicated with the duodenum, twenty-six with the colon, four with both colon and duodenum and only six with the stomach. In Bernhard's³ series of 109 cases, fifty-six represented spontaneous communications between the biliary tree and the duodenum, thirty-six with the colon, twelve with the stomach and five with multiple viscera. These figures are in accord with the incidence of the various types as reported in smaller series and isolated case reports.

PATHOGENESIS

The question of the primary pathologic process responsible for the appearance of the fistulous tract is of considerable interest. With the exception of occasional isolated cases, spontaneous internal biliary

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fistulae appear as complications of one of three pre-existing conditions, namely, chronic calculous cholecystitis, peptic ulcer, and gastrointestinal malignancy. Well over 90 per cent of all these cases reported in the literature have been ascribed to chronic cholecystitis in one of its various stages. The high incidence of these fistulae in the female, three to one, is merely an index of the usual preponderance of gallbladder disease in that sex. Wakefield, Vickers and Walters⁴ in discussing cholecystocentric fistulae state that they are produced in one of three ways: by perforation of the gallbladder and intestine by stones, by perforation of the intestinal tract and gallbladder by a peptic ulcer and by perforation of the intestines and gallbladder by carcinoma.

It seems likely, therefore, that calculous cholecystitis is essential to the formation of a large majority of the spontaneous internal biliary fistulae that appear. Exceptions would include perforating peptic ulcers, gastrointestinal malignancy involving the stomach or the proximal end of the transverse colon and malignancy of the gallbladder or ducts with ultimate extension into the gastrointestinal tract. Davison and Aries² report an unusual instance of spontaneous anastomosis between the short proximal end of a traumatically severed, strictured common bile duct and the pylorus of the stomach.

Dean⁵ offers the following logical explanation for the appearance of an internal fistula on the basis of gallbladder disease:

"After repeated attacks of acute inflammation, the gall bladder or bile ducts become adherent to the nearest portion of gut. The first part of the duodenum, the proximal end of the transverse colon, and the pyloric end of the stomach are the usual sites of involvement, in the order of their frequency. Then during an acute attack perforation of the adherent visceral walls occurs due to the necrotizing action of contained calculi or bulging empyema. . . . Another possibility is that rupture of a diseased gall bladder produces a pericholecystic abscess which secondarily necrotizes the gut wall to establish the fistula."

Eliason and McLaughlin,⁶ in a discourse on perforation of the gallbladder, state that these perforations occur in from 1 to 3 per cent of all cases of biliary disease and further that perforation usually occurs in patients with a long standing history of chronic calculous cholecystitis. They report a case of a 57 year old, white male, operated upon for common duct obstruction and found at operation to have, in addition to common duct stones, a circular, firm gallstone, 2.5 cm. in diameter, lodged in the meso of the hepatic flexure of the colon adjacent to the gallbladder fossa. The stone had not crooked into the lumen of the colon but does serve as an excellent example of a step in the formation of the internal fistula through the medium of gall-bladder disease. The remaining forms of internal spontaneous fistulae are medical curiosities and their pathogenesis of little moment.

DIAGNOSIS

As has been indicated above, the diagnosis of this condition is usually made at the operating or autopsy table. When one considers that the majority of these fistulae appear with no suggestive subjective or objective signs, the conclusion is forthcoming that diagnosis is an important issue. The subjective symptoms associated with the presence of a fistula are usually those compatible with non-fistulous biliary tract disease. Occasional situations arise which may cast some diagnostic light on the pathologic process present. It has been pointed out that many patients receive sudden and often permanent relief from all their symptoms when the fistula is formed and free access to the gastrointestinal tract is afforded for the septic biliary contents. Dean⁵ reports such an instance in a patient diagnosed preoperatively. This patient developed a tender, palpable gallbladder during a typical attack of acute cholecystitis. After a few days the palpable mass disappeared together with the associated acute pain. Within the next forty-eight hours the patient developed an acute intestinal

obstruction. At operation a large gallstone was found impacted in the lower ileum. This patient was the only one in his series of twenty-nine cases in whom the symptoms indicate the time of formation of the fistula.

The passage of gallstones by bowel or their emesis and expectoration is strong presumptive evidence for suspecting the presence of an internal biliary fistula. One must bear in mind, however, that while vomiting of gallstones is suggestive of a gastric or upper duodenal communication, it is not necessarily so, since bile is frequently regurgitated into the stomach and it is conceivable that small stones could accompany it. Intestinal obstruction due to intraluminal stones occasionally has been the basis for a diagnosis of an internal biliary fistula. The passage of stones with the feces is significant only if the stones are too large to have passed through the ampulla of Vater. According to Wangenstein⁷ a case of obstruction due to a gallstone is invariably an indication of the presence of an abnormal communication between the biliary passages and the gastrointestinal tract. Instances are reported in which an intestinal obstruction is said to have occurred in the absence of such an abnormal communication. In such instances, however, it would appear unlikely that the gallstones were large enough to cause a mechanical block of the bowel, for rarely if ever do stones of that size pass through the ampullary opening of the choledochus. The usual site of lodgment is in the lower ileum. It has been shown that the fistula may not remain patent, for at the time of operation or post-mortem the only evidence of a fistulous tract frequently is the presence of dense adhesions.

The diagnosis of acute intestinal obstruction due to gallstones should be considered in any patient who suddenly develops signs and symptoms of intestinal obstruction after a prolonged period of biliary tract disease. Wakefield, Vickers and Walters⁸ are of the opinion, however, that a history

of chronic cholecystic disease is of no value, since in many cases intestinal obstruction, regardless of the cause, is accompanied by such a history. Of their ten reported cases of intestinal obstruction due to gallstones occurring at the Mayo Clinic, only three had definite symptoms of chronic cholecystic disease. Two had an indefinite history, and the rest had no symptoms ordinarily associated with such a condition. One significant point which they did point out in speaking of these cases was the fact that five of the ten cases had recurring attacks of intestinal obstruction prior to the onset of a complete ileus. McQueeney⁹ emphasizes this same feature of gallstone obstruction in his study of 149 cases gathered from various authors. He states that approximately 2 per cent of all cases of intestinal obstruction are due to gallstones. A large percentage of these presented intermittent obstruction. From his review of their case histories he gathered that at first the obstruction was incomplete. Relief was apparently afforded by the stone's moving back into a larger segment of the intestine. Finally, the stone, being propelled into a narrow part of the ileum, becomes lodged there and produces a complete block. In practically every case in which the location of the obstruction was mentioned it was within two feet of the ileocecal valve.

A review of the world's literature by Lowman and Wissing¹⁰ revealed ten cases in which a definite roentgenographic diagnosis of gallstone obstruction was made prior to operation. They added one additional case to this series from their own practice. All of these diagnoses were made by employing a contrast medium in the roentgenography of the gastrointestinal tract. As pointed out by Ochsner¹¹ one must recognize in such cases the risk associated with the oral administration of barium sulfate because of the danger of making the ileus more acute. It is conceivable that a simple scout film of the abdomen may visualize a radio-opaque stone at some point distant to the gall-

bladder region in a patient suffering from intestinal obstruction, thus suggesting an intraluminal calculus as the obstructing factor.

Despite the apparent difficulty in clinically diagnosing the presence of a spontaneous internal biliary fistula, Lönner Blad,¹² writing in *Acta Radiologica* in 1932, was able to collect from the current literature forty proven cases of spontaneous internal biliary fistulae diagnosed roentgenographically in addition to two cases of his own similarly diagnosed. Roentgenographic diagnosis, though rarely applicable, is based upon the demonstration of air or a contrast medium in the bile passages, thus showing the probable presence of an artificial fistulous tract. It is a well known fact, however, that the passage of barium through the ampulla of Vater and up into the common duct is occasionally encountered in routine gastro-intestinal roentgenography. Since Lönner Blad's paper appeared there have been a number of isolated cases diagnosed pre-operatively and incidentally in this manner.

CASE REPORTS

Because of the relative infrequency of this condition experienced in other clinics we wish to report five cases of spontaneous internal biliary fistula encountered on Surgical Section A in the Hospital of the University of Pennsylvania during the past seventeen years.

CASE I. C. Y., female, 63 years of age, was admitted to the hospital complaining of nausea and vomiting of four days duration. The patient had previously been perfectly well with no complaints referable to the biliary or gastro-intestinal tracts. Four days preceding her hospitalization she began to complain of intermittent, colicky abdominal pain associated with nausea and later vomiting. The vomiting, at first bile stained, gradually became fecal in character. She had not had a bowel movement during the five days preceding her admission.

Physical examination showed a dehydrated, white female with the tumultuous peristalsis of mechanical obstruction and abdominal distention. There was moderate tenderness in the

R.U.Q. The diagnosis was acute intestinal obstruction.

At operation the day following admission a tremendously dilated small gut was found proximal to a huge gallstone obstructing the lumen of the upper ileum.

Note: This patient illustrates gall stone intestinal obstruction appearing in an individual with no previous history of gall-bladder disease. The site of obstruction is quite typical.

CASE II. J. R., female, 79 years of age, was admitted to the hospital complaining of jaundice, fever, chills and abdominal pain. Nineteen years before her gallbladder had ruptured into her duodenum. Four days later she developed acute intestinal obstruction due to a gallstone in the upper ileum. She was operated upon successfully and remained perfectly well until five days before this, her final admission, when she began to complain of a dull, aching epigastric pain. The pain gradually developed into an attack of gallbladder colic associated with Charcot's fever, chills and jaundice.

Physical examination revealed an acutely ill, delirious, deeply jaundiced, obese female, with tenderness in her right upper quadrant, fever and leukocytosis. The diagnosis was common duct obstruction, chronic calculous cholecystitis.

Although in desperate condition she was explored under local anesthesia and an internal fistulous tract between the gall-bladder and the second portion of the duodenum was found. The gallbladder was filled with gas and white bile and in addition contained three stones. The opening of the duodenum was repaired and a cholecystostomy and choledochostomy performed. The patient died within twenty-four hours of operation without regaining consciousness.

Note: This case serves to illustrate a spontaneous internal biliary fistula, present asymptotically for nineteen years, suddenly producing symptoms when, due to closure, the fistula no longer was able to serve as a "cure" for the pre-existing pathologic process.

CASE III. S. B., female, 73 years of age, was admitted to the hospital complaining of epigastric pain and tenderness. During the preceding twenty-eight years she had suffered repeated

attacks of gallstone colic. On at least two occasions she had been visibly jaundiced. A Graham-Cole test performed two years before revealed multiple calculi in the gallbladder.

Physical examination on admission revealed an acutely ill patient with fever, leukocytosis, R.U.Q. tenderness and rigidity. The diagnosis was chronic calculous cholecystitis with cystic duct obstruction.

The abdomen was explored through an upper right rectus incision and an acutely inflamed gallbladder was found practically filled with a large stone. A second stone was lodged in a pouch at the ampulla. A fistulous tract passing between the second portion of the duodenum and the gallbladder was discovered. The fistulous opening in the duodenum was closed and a cholecystostomy performed. The patient died of cardiac failure on her seventh postoperative day.

Note: This patient presents an example of a cholecystoduodenal fistula appearing as a complication of a long standing chronic calculous cholecystitis. A large percentage, indeed the majority, of spontaneous internal biliary fistulae would fall into this group.

CASE IV. A. G., female, 69 years of age, was admitted to the hospital complaining of abdominal pain and vomiting of forty-eight hours' duration. For six years she had been having attacks of right upper quadrant pain without jaundice. Three days preceding her hospitalization she developed signs and symptoms of an acute intestinal obstruction.

Physical examination on admission revealed a desperately ill patient with fever, leukocytosis, a distended abdomen and hyperactive peristalsis appearing in rushes. Her abdomen was tender and rigid throughout. The diagnosis was acute intestinal obstruction.

During her first forty-eight hours in the hospital she began to improve symptomatically, passed gas by bowel and lost most of her distention. Finally her obstructive symptoms reappeared and operation was performed on her third hospital day. An extensive carcinoma of the gall-bladder which had perforated into the duodenum was found. In addition there was a large gallstone lodged in the lumen of the jejunum producing intestinal obstruction. Adjacent to the stone there was a small eroded, perfora-

tion of the jejunal wall and a resulting peritonitis. The patient died on the day of operation.

Note: This case illustrates one of the unusual types of cholecystoduodenal fistulae appearing in a patient with carcinoma of the gall-bladder. It further bears out the statement that gallstone ileus is often characterized at first by partial and intermittent obstruction and later becomes complete. The jejunal perforation from an intraluminal stone is an unusual and bizarre complication.

CASE V. M. S., female, aged 72 years, was admitted to the hospital complaining of severe colicky epigastric pain, obstipation and vomiting of six days' duration. Ten months previously she was admitted to another hospital with a diagnosis of acute cholecystitis. She refused operation and proceeded to recover from her acute right upper quadrant pain and tenderness without event. She had remained well until the onset of her recent difficulties beginning six days before. During this period preceding admission her vomiting continued ten to twelve times daily and became fecal in character.

Examination on admission revealed a dehydrated, apathetic, white female complaining of paroxysmal right lower quadrant pain and repeated vomiting of fecal-like material. There was a right lower quadrant appendectomy scar with an associated incisional hernia which was easily reduced. The abdomen was markedly distended and peristalsis was of the hyperactive, obstructive type. In addition, the patient was suffering from auricular fibrillation. Blood serum chlorides—60 milliequivalents per liter; B.U.N.—90 mg. per cent. A roentgenogram revealed multiple distended small bowel loops. After decompression of the small bowel via Miller-Abbott tube and correction of fluid and electrolyte balance, the patient was operated upon under spinal anesthesia. A large gallstone 3 cm. in diameter was removed from the ileum where it was producing complete obstruction. Subsequently, the patient made an uneventful convalescence.

This, the last of our series, represents the picture and history commonly associated with spontaneous internal biliary fistulae resulting in intestinal obstruction—a long-standing gallbladder history fol-

lowed by the sudden onset of acute obstruction. So suggestive was the history that a preoperative diagnosis was made.

SUMMARY

1. We have considered briefly the incidence, the relative frequency of the various types and the pathogenesis of spontaneous internal biliary fistulae.

2. In addition we have studied the reported cases from the medical literature in an effort to ascertain the characteristic diagnostic features common to many.

3. Finally, we have reported five cases taken from our own records during the past seventeen years, all of which in some measure bear out the aforementioned factual data recorded in other clinics.

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STAPHYLOCOCCUS PROSTATITIS TREATED WITH STAPHYLOCOCCUS TOXOID*

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IN the twenty-seven cases of prostatitis reported here, staphylococcus was either the only or the predominant organism present. The staphylococcus is considered to be of pathologic significance only when the prostatic smear, as well as the prostatic culture, is strongly positive. It must be remembered that staphylococcus is the organism normally found about the glans penis, prepuce, and fossa navicularis.

Staphylococcus albus is found much more frequently than *Staphylococcus aureus*, especially in urethral discharges. *Staphylococcus aureus*, when present, causes more profuse suppuration and more severe constitutional effects. It is suggested that staphylococci normally present may become pathogenic when the lining of the genitourinary tract becomes damaged. It is also wholly possible that a descending infection from the upper genitourinary tract may give rise to a staphylococcus infection in the lower genitourinary tract.

The prostate is probably the most common organ of the genitourinary tract to be invaded by the staphylococcus. The individual with such an infection may be completely unaware of its source, as far as his symptoms are concerned. The first sign may be repeated attacks of boils, the focus of which is the prostate.

The symptoms found in this series, in order of frequency, were: (1) nonspecific mucoid discharge, found in twenty of the twenty-seven cases; (2) pain in the lower lumbar and sacroiliac regions; (3) pain and fatigue in the calves of the legs, especially toward the end of a working day; (4) headache; (5) terminal pain on urination; (6)

burning on urination; (7) general malaise; (8) posterior urethral discomfort; (9) burning at the tip of the penis; (10) perineal discomfort (itching and crawling sensations); (11) pain in the inguinal region.

Tenderness of the prostate was a more or less constant finding in all the cases studied, sometimes accompanied by hypertrophy. Cases occurring in men from 30 to 50 years of age were intentionally selected in order to rule out the complicating problem of such hypertrophy.

Each of the twenty-seven patients studied underwent the following treatment:

1. Smear and culture of the prostatic fluid.
2. Grading of the type of prostatic enlargement.
3. Initial intradermal skin dose of .01 c.c. of the toxoid† on the volar aspect of the forearm.
4. Reading of the resultant reaction in twenty-four hours, and if the resulting erythema were 3 by 3 inches or less, then:
5. A biweekly subcutaneous injection of .1 c.c. of the toxoid with doses increasing by .1 c.c. in alternate detoxoid regions.
6. When 1 c.c. was reached, the dose was repeated weekly for two months.
7. Prostatic massage every ten days to promote adequate drainage and to note the changes in the cell population of the expressed fluid.

The initial smear was usually high in total cell count. Many times the staphylococcus organisms could easily be made out, but the culture was the determining factor

† Product used was staphylococcus toxoid #2, prepared by Lederle. It is of the 1000 unit strength and is the same as that previously issued undiluted.

* From the Department of Urology, New York Post-Graduate Hospital and Medical School, Columbia University, Joseph A. Hyams, M.D., Director.

in deciding whether the case would be classified with the group we were studying. The most frequent organisms accompanying the staphylococcus in the cultures were found to be:

1. Diphtheroids of undetermined classification. We are inclined to agree with Cumming and Chittenden that these are probably mutations of the staphylococcus.

2. Hemolytic streptococci.

3. Large Gram-positive cocci, classification undetermined. These are mentioned frequently by various investigators and are thought by most to be nonpathogenic.

Twenty-five colonies per loopful of either *Staphylococcus aureus* or *albus* were considered a positive culture.

The most common symptoms complained of following the toxoid injection subcutaneously were:

1. Fever: 100°–101°F. The 101° temperature occurred in only one of our patients.

2. Rheumatoid pains in the neck and arms, and between the shoulders.

3. Dull frontal headaches.

4. Local soreness in the immediate area of injection.

5. Slight induration about the injected site.

If during the period of increasing dosage to the 1 c.c. dose, the individual experienced any of the above symptoms, he was then given exactly the same dose he received at the last treatment, and kept on this dose until these symptoms disappeared.

Toxoid is prepared from staphylococcus toxin by the addition of formalin in the same manner as the diphtheria prophylactic is produced. Dolman and Whitby have reported encouraging results with the staphylococcus toxoid.

The toxoid is issued in two strengths, weak and strong, the weak being one-fifth to one-tenth of the strong. The latter was used in this study.

There were two failures in this series: one had many orthopedic complaints which confused any attempt at effective cure. The other patient, while under treatment for his prostatic infection, was also being

treated for a series of infected sebaceous cysts. In addition, he had an infected right ethmoid sinus.

Results of treatment were: (1) relief of initial symptoms in twenty-five of the twenty-seven cases; (2) subsidence of initial signs; (3) generalized constitutional improvement evidenced by a gain in weight, improvement of skin tone, and an increased energy quotient; (4) final negative prostatic smear as evidenced by a normal cytology of the prostatic fluid; (5) absence of the staphylococcus from the culture of the prostatic fluid; (6) satisfactory removal of all infected foci.

DISCUSSION

It is most important to rule out other possible foci of infection. The two failures in this series are attributed to our inability to recognize that the prostate was a secondary focus. This is further proved to be true in the case of the patient with the infected sebaceous cysts and sinuses. After these had been effectively treated, the prostate was cleared rapidly of its infection.

Patients presenting the initial symptoms listed elsewhere may have what appears on palpation to be a normal prostate gland. Such a gland, if infected with staphylococcus, may be etiologically important. This type of gland may appropriately be compared to the small, buried, innocent-looking tonsil which often is a more dangerous focus than the huge tonsil with better drainage.

We have noted the change from leucocytes to monocytes in the prostatic fluid as the prostate frees itself from the staphylococcus organisms. Cumming and Chittenden mention the change in cell population and suggest that these monocytic cells are in some way linked to the production of immune reactions. It would follow, then, that too frequent prostatic massage is undesirable.

It is entirely possible that the bacteriostatic or bactericidal contents of the prostate diminish as age advances. That these bacterial properties are known to exist has

been shown by Farrell, and they may be sufficient to allow natural or induced immune reactions to rid the prostate of infection in younger individuals. Advancing age may produce a prostate more liable to invasion by pathogenic organisms.

The author wishes to express his appreciation of the assistance of Dr. Donald J. Kissinger and other members of the Clinic Staff.

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HEALING OF TUBERCULOUS NEPHRECTOMY SINUSES*

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REMOVAL of a tuberculous kidney is generally considered a most harrassing experience both for the patient and the surgeon. The most frequent complications of the postoperative period are breakdown of the nephrectomy incision and the formation of sinus tracts. Since either of these distressing sequelae is of considerable consequence in adding to the discomfort of the patient as well as the duration of his disability, their prevention is a chief concern of the surgeon. Previously, effective treatment of such a stubborn condition as a tuberculous sinus has left much to be desired. Consequently, it is believed that the authors' experiences with a new prophylactic and therapeutic technic, using a triolein ozonide,¹ will prove of interest and value to the profession in dealing with such problems.

The surgical technic comprises complete nephroureterectomy, with scrupulous attention to complete excision of the ureter; if even a small tuberculous stump of the ureter remains, it is likely to provide the source for development of a sinus. The wound is closed without the use of drains or retention sutures since both of these tend to encourage sinus formation.

The importance of exercising extreme care in the surgical procedure cannot be overemphasized. A sinus may develop from a tuberculous ureteral stump long after the nephrectomy incision has united by apparent primary healing. On several occasions, well healed wounds have been observed to break down as long as four months after operation. Many patients

referred to Sea View Hospital for care of their pulmonary tuberculosis are found to have gaping wounds or draining sinuses resulting from a nephrectomy which had been performed elsewhere in the usual manner.

Several methods have been tried over a considerable period of time in an attempt to discover a satisfactory method of treating these lesions. Silver nitrate, cod liver oil, ether, azochloramide, gentian violet, methylene blue and other chemical agents have been employed, each being associated with occasional success. Until recently, our most effective method consisted of the daily use of ether and 25 per cent silver nitrate, by means of which, in spite of its disadvantages, many of the sinuses healed completely or closed to such a degree that revision could easily be done. The two outstanding disadvantages of this régime have proved to be: (1) the sinuses drain profusely of a silver proteinate until they are almost completely healed, and (2) the treatment is associated with varying degrees of pain and discomfort to the patient.

In searching for an effective agent which would prove successful in the stimulation of healing and at the same time add to, rather than detract from, the comfort of the patient, it was determined to study the effects of ozonized olive oil. This type of chemotherapy has been used in fifteen cases, and in the majority of instances has produced very gratifying results.

The technic of this therapy consists in daily instillation of a quantity of the ozonized olive oil sufficient to fill the sinuses completely. Since this preparation contains heat, moisture, labile ozonides of triolein and other unsaturated hydrocarbons, significant quantities of nascent

¹ Grateful acknowledgement is made to the Research Department of The G. F. Harvey Company through whose courtesy the triolein ozonide used in this study was supplied.

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FIG. 1. Typical "gaping" nephrectomy wound four months after operation (referred case having had usual treatment).



FIG. 2. Deep sinus tract persisted for three months after operation. Photo shows result of one month's ozonide treatment. Wound almost entirely healed; only surface remains open and is very clean.

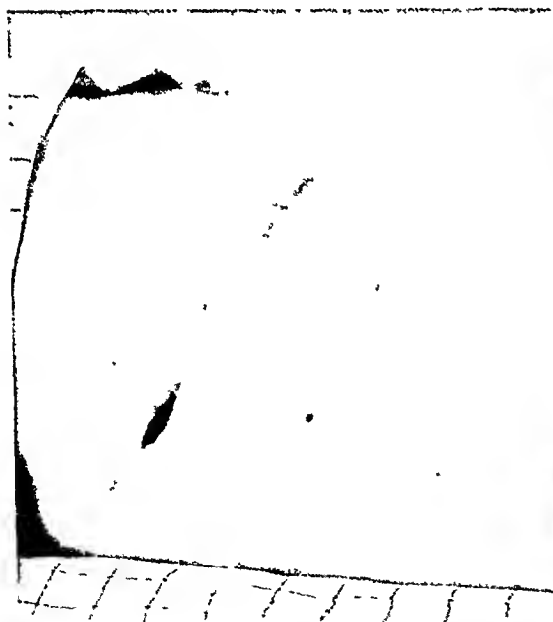


FIG. 3. Extraordinary case of a single sinus which appeared when the wound broke down four months after apparent healing. The patient is now receiving triolein ozonide solution irrigations.

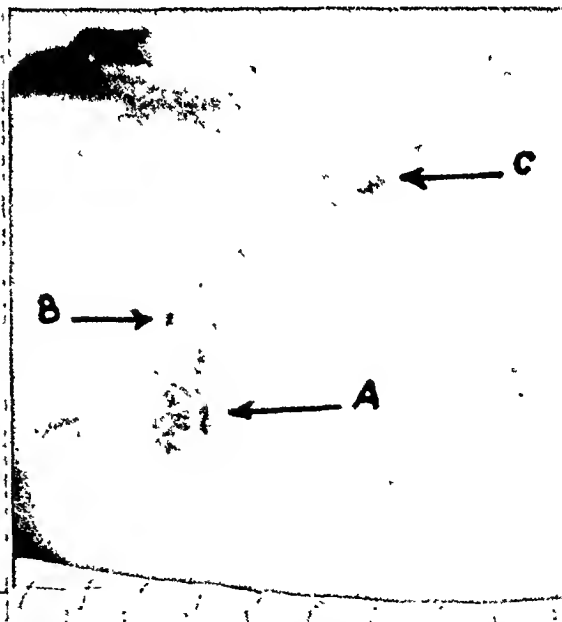


FIG. 4. Complete healing of deep multiple sinuses (A, B, C) after six weeks of ozonide treatment. Particularly difficult was the small sinus at B which developed along canal of retention suture (referred case).

oxygen are released over a prolonged period into the tissues of the sinus walls, where it acts as a bactericidal agent and a stimulant to local cellular metabolism. Sterilization of the wound and proliferation of tissue elements are thus promoted without the destruction of the surrounding healthy tissue.

Under this method of therapy the wounds have in most cases healed at a constant and satisfactory rate. In those lesions which were gaping, the exposed surfaces assumed a clean and fresh aspect without excessive granulation or sloughing. A further advantage of this technic lies in the increased comfort experienced by the patient as well as the markedly diminished drainage from the sinuses and open wounds.

Of the fifteen cases in which the solution of triolein ozonide in olive oil has been used, thirteen sinuses were completely healed in from two to five months. One wound, which had been wide open from the time the sutures were removed on the fourteenth postoperative day and which had showed no evidence of healing during two months when other types of therapy were used, healed readily under treatment with the ozonized olive oil to such an extent that revision was easily done. The wound in the fifteenth patient was healing satisfactorily with this new therapy and there remained but a single small sinus, when the patient left the hospital without consent.

SUMMARY AND CONCLUSIONS

Removal of the tuberculous kidney entails the danger of nonhealing of the operative incision as well as sinus formation and re-opening of the wound even after apparently perfect healing has occurred.

A surgical technic to help prevent these postoperative sequelae includes close attention to the problem of entire removal of the ureter, leaving no tuberculous stump to serve as the origin for a later sinus.

Many therapeutic agents have been used with only moderate success to secure healing of wounds and sinuses. Recently a new agent, triolein ozonide, has been used with marked success in fifteen patients.

This substance releases nascent oxygen upon contact with body heat and moisture. Its oxygen is released slowly over a period of many hours, affording sterilization of the wound and promoting reparative processes through stimulation of local cellular metabolism in the oxygen-starved tissues of the wound. Its simultaneous liberation of an aldehyde affords a soothing analgesic effect which makes the patient more comfortable.

Although the use of this medication has been most gratifying, no definite conclusions can be drawn at this time since the number of patients treated has been relatively small. However, it is hoped that this preliminary report may stimulate others to a further investigation of this preparation in this and similar uses.



THE IDEAL DRESSING FOR CLEAN WOUNDS

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UPON the completion of a surgical procedure and the closure of the skin incision, one somehow feels that dry gauze is the proper material with which to cover the incision, and consequently proceeds to apply the sterile dry dressing over the wound and to fasten it to the adjacent skin with adhesive strips. The idea of using dry gauze is perhaps to absorb any oozing that might occur from the wound and to protect the wound from contamination through contact with clothes, bedsheets, etc.

However, despite serving these two purposes dry gauze falls short of fully achieving either goal. While dry gauze might absorb the first few drops of blood or serum, the oozing is usually so slow that evaporation through the dry gauze and coagulation of the blood promoted by its contact with the rough, dry gauze hastens the formation of a crust which seals the wound and prevents further oozing. As a result, serum stagnates in the wound and increases the chances of wound infection. Not only do the chances of infection become greater, but an accumulation of serum actually interferes with wound healing; for when the layers of tissue are bathed in serum and separated from each other, the growth of fibroblasts between them is retarded, and union of the layers other than the skin is slow, thus predisposing the wound to disruption or postoperative herniae.

Furthermore, should the dressing be inadvertently soiled, the dry gauze invites contamination by virtue of its capillarity; and acting like a wick instead of warding off the danger of infection, it steers the infected material directly into the wound. Even without spillage of fluids on the dry dressings, the circulation of unsterile gases

through the dry gauze might carry infection into the clean wound. Dry gauze is, therefore, far from being the ideal dressing for wounds.

The best dressing for an operative wound would be one which allows for as much oozing from the wound as possible, which retards crust formation and adhesion of the approximated skin edges, and at the same time protects the wound and minimizes the dangers of contamination from the outside. Such properties are possessed by a dressing composed of a stable, nonevaporating, anticoagulant substance such as petrolatum jelly.

But petrolatum jelly, when applied to the wound and covered with gauze, diffuses through the entire dressing and dries up particularly when, as in elderly patients, sutures and dressings are left more than a few days. To overcome this handicap, the petrolatum jelly may be spread over the wound and covered by a sheet of non-absorbent material upon which the dry gauze pads may be applied. This sheet would be of further value if composed of a transparent material such as cellulose film commercially known as cellophane. The moisture-proof variety is particularly suited for this purpose because it is not affected by steam sterilization when autoclaved under twenty pounds of pressure for forty-five minutes—the average exposure required for the sterilization of dressings.

With this combination dressing of petrolatum jelly, cellulose film and dry gauze, the wound is satisfactorily preserved from outside contamination and the sealing off of the skin incision is retarded and allows for more drainage than in the case of dry gauze. Should wound infection be suspected and inspection of the wound become advisable, the wound itself need not be dis-

turbed for the transparent film would permit inspection and even palpation without exposure of the incision.



FIG. 1. Dressing removed; cellulose film is still in place.

RESULT OF EXPERIMENT

To determine the effect of petrolatum jelly upon the growth of common bacteria, Dr. Peter P. Fiore, of the Department of Bacteriology, conducted the following ex-

periment of fifteen days. The broth and petrolatum jelly cultures were inspected daily. It was noted that none of the organisms showed any growth on the plates with petrolatum jelly at any time during the fifteen days, while all organisms showed growth in the beef broth medium. The experiment was repeated by preparing petri dishes filled with 20 cc. of plain beef infusion agar to which 2 cc. of citrated rabbit's blood were added. After solidification a triangle of about three-fourths inch was cut in the center of each dish and this was filled with sterile petrolatum jelly. The plates were streaked across with cultures of the ten selected organisms and the dishes were again incubated for a period of fifteen days. Three of the bacteria showed growth over the vaseline triangle, apparently because of the implantation of pieces of the solidified beef infusion blood agar over the vaseline by the wire loop. When the experiment was repeated and the bacteria carrying loop was streaked radially



FIG. 2. Illustration showing the cellulose film being removed.

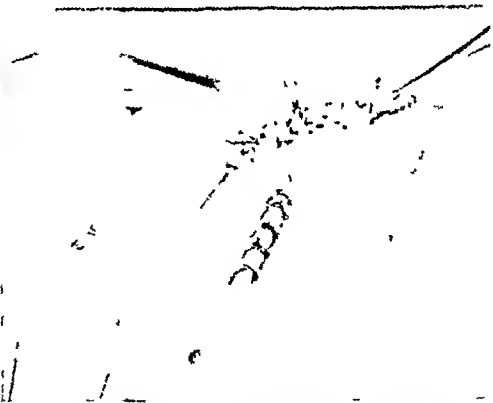


FIG. 3. Illustration showing the wound after removal of cellular film sheet.

periment: Ten organisms were selected for the study: staphylococcus hemolyticus, hemolytic streptococcus, *B. coli*, *B. proteus*, diphtheroid bacillus, pneumococcus, staphylococcus albus, *B. pyocyaneus*, anaerobic streptococcus, and clostridium Welchii. Cultures of each were grown on sterilized petri dishes filled with petrolatum jelly. The same cultures were grown simultaneously in broth for control and both sets of cultures were incubated for a

from the petrolatum jelly triangle, no growth was seen over the triangle at any time during the fifteen days.

A distinct advantage of this dressing is the ease with which it comes off without pain to the patient. Nor can it pull off fresh granulations or new epithelium when changed because it does not stick to the wound. It is particularly valuable in the case of wounds closed with the newer type of skin clips whose upper prongs often hook

on to the gauze, thus making the removal of a dressing a tedious procedure.

The dressing is simple to prepare. The cellulose film may be cut into 2×4 inch sheets and each sheet wrapped separately in a piece of paper then autoclaved; or a long ribbon of film about two inches in width may be wrapped between two layers of bandage around a tube of petrolatum jelly. The tube with the cellulose film wound around it may then be added to the laparotomy bundle before the latter is placed in the autoclave.

Once the skin is sutured, the wound is cleaned with an alcohol sponge and the jelly is spread over a piece of cellulose film and the latter applied over the wound. The jelly may also be spread over the incision and a piece of cellulose film, slightly longer than the incision, is cut and plastered down upon the jelly covered wound. Dry gauze pads are applied on top of the film and secured in place by adhesive straps.

SUMMARY

A dressing of petrolatum jelly spread over a wound, covered with a film of cellulose and then dry gauze pads is the ideal dressing for a clean postoperative wound because:

1. It promotes oozing from the wound by virtue of its anticoagulant, antievaporant properties.
2. It seals the wound to accidental spilling of infected material and prevents contamination of the wound with infected gases.
3. It facilitates the inspection of the wound whenever infection is suspected.
4. It relieves the patient of pain and saves the surgeon's time when the dressing is changed.
5. It prevents the pulling off of growing epithelium and fresh granulations when removed.



Case Reports

PRIMARY URETERAL CARCINOMA*

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PRIMARY ureteral malignancies challenge the diagnostic skill of the physician because of their insidious onset, obscure symptomology and high mortality. The following case is presented because of its allied interest:

CASE REPORT

J. W. S., age 59, was admitted to the Huntington Hospital on March 3, 1939, because of two attacks of severe right lumbar colic, radiating anteriorly and towards the serotum. Associated with this were frequency, urgency and dysuria. The first attack occurred six weeks previously and subsided with the administration of a sedative. The second attack took place a week prior to admission and was associated with hematuria, nausea and vomiting.

The patient's general health had been fairly good save for recurrent attacks of sinusitis and bronchial asthma. Tuberculosis of the left lung was suspected at one time. A right orchidectomy was performed four years previously for a suppurative epididymo-orchitis. The family history was significant in that the patient's mother and three sisters had died of carcinoma of the uterus.

Physical examination revealed a rather thin adult male, apprehensive about his condition. Temperature, pulse and respiration were normal. The skin had a slight subicteric tint. Lips and other mucous membranes were pale. In the right upper chest the breath sounds were associated with musical rales and rhonci. The whispered voice was exaggerated at the right apex posteriorly. Vocal fremitus was normal

throughout the chest. The heart was not enlarged; the sounds were of fair quality; no murmurs were heard.

The abdomen was soft. Vague tenderness could be elicited in the right costovertebral angle and flank. The genitalia was essentially negative save for the absence of the right testis. On rectal examination the anal tone was good, while the prostatic bed felt firm and granular. The extremities were entirely normal.

Laboratory Data. Urine: Voided, single, light amber, slightly cloudy, acid reaction, specific gravity 1.012; albumin, very faint trace; sugar, negative; acetone, negative; diacetic acid, negative; numerous mucous shreds; epithelium, few renal; pus, 0-1 (h.p.f.); bacteria, 4 plus.

Blood count: Hemoglobin 81 per cent (Sahli); red blood cells, 4,240,000; white blood cells, 13,400; small lymphocytes, 11; large lymphocytes, 4; polynuclear neutrophils, 82; eosinophiles, 2; basophiles, 1.

Blood urea nitrogen, 13.1 mg. per 100 c.c. blood. Blood Type II. Wassermann: Negative.

Urological Survey. Plain film of the K. U. B. tract revealed normal renal outlines. Intravenous pyelography showed a 2 plus hydronephrosis and hydroureter, with a kink formation in the upper third of the ureter. A persistent filling defect 2 X 1 cm. was present in the lower segment of the right ureter.

Cystoscopy. Examination was performed under spinal anesthesia (50 mg. novocaine crystals). The instrument entered easily. The bladder mucosa was pale. Both ureteral orifices and trigone were normal. The vesical neck presented a normal contour, while the posterior urethra was moderately injected. No tumors, stones or diverticula were seen. Intravenous

* Presented before Section on Genito-Urinary Surgery, New York Academy of Medicine, February 21, 1940.

indigo-carmin appeared within five minutes from the left ureteral orifice, with strong intensity and normal peristalsis. No dye could

whistle-tip catheter to the renal pelvis (28 cm.). The return flow was of strong blue concentration and rapid flow. The left ureter was simi-



FIG. 1. Right pyeloureterogram. Note filling defect in lower ureteral segment.



FIG. 2. Enlargement of filling defect in lower ureter. Note papillary outline.

be seen from the right ureteral orifice for fifteen minutes.

The right ureter was catheterized with No. 5

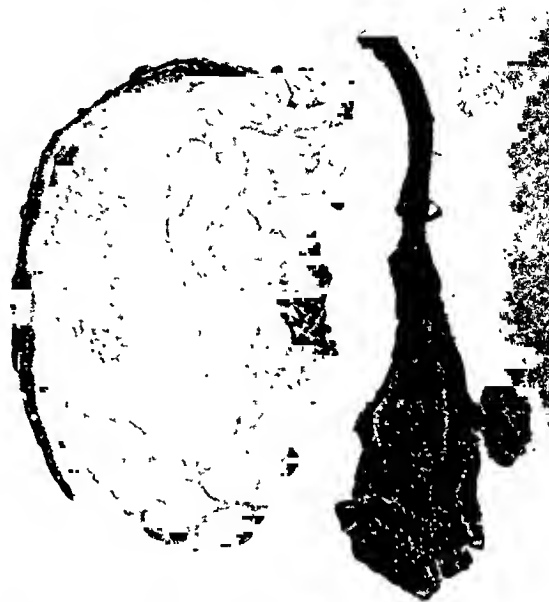


FIG. 3. Kidney and ureter, showing pedunculated tumor.



FIG. 4. Ureteral tumor seen in Figure 3. The bed of the tumor within the ureteral lumen can be seen.

larly catheterized to the renal pelvis without encountering any obstruction.

Bilateral pyelo-ureterograms were performed with 20 per cent hippuran. Upon withdrawing the right ureteral catheter, one noticed some



FIG. 5. Arrow marks point to malignant invasion of the hilum lymph nodes.

tissue within the meatus of the ureter. This was picked up with rongeur and sent to the laboratory for tissue study. Specimens from both sides, including the bladder, appeared grossly normal.

	Microscopic	Gram Stain	Tuberculosis	Culture
Right kidney.	40-50 R. B. C.	Negative bacilli and cocci	Negative	Sterile
Left kidney.	15-20 W. B. C.	None	Negative	Sterile
Bladder	0-1 R. B. C. 0-3 W. B. C. Few mucous or renal shreds	No organism	Negative	Sterile

Urological Diagnosis: Tumor right ureter (?).
Right hydronephrosis.

Biopsy specimen: Insufficient material for diagnosis.

X-ray examination of the urinary tract after a retrograde pyelogram showed the following: The left side was not completely injected but the renal pelvis, calyces and ureter appeared normal. The pyelogram of the right side showed a marked dilatation of the calyces and less marked of the renal pelvis, which was bifid. The ureter was somewhat redundant and dilated. There was a tremendous dilatation of the lower end with a persistent filling defect in the lower ureter which appeared to expand the

lumen. The defect was somewhat polypoid in appearance. One concluded that the hydronephrosis and hydroureter were secondary to the ureteral tumor.

A stereoscopic x-ray examination of the chest revealed a large mass occupying the right hilum, probably due to metastatic carcinoma in the hilum lymph nodes. One notes an indefinite shadow in the right second interspace anteriorly which may be the result of a lobular atelectasis due to bronchostenosis. An emphysema is also seen in both lower lobes. X-ray examination of the skull showed no abnormality in the cranial vault. Subsequent x-ray examinations of the chest at two weekly intervals disclosed an increasing atelectasis of the entire upper lobe of the right lung.

In view of the apparent seriousness of the case, the advisability of a nephro-ureterectomy followed by deep x-ray therapy to the lungs was considered. The patient's condition, however, grew progressively worse. He experienced repeated asthmatic attacks which did not respond to adrenalin therapy. Death occurred March 30, 1939, a month in which all malignant members of the family had expired.

An autopsy performed by Dr. G. Priestman (Kings Park, New York), revealed the following gross findings: (a) Small pedunculated papillary tumor of the lower right ureter (Figs. 3 and 4); (b) small neoplasms on the surface of the liver; (c) malignant growth in the upper lobe of the right lung; (d) malignant growth in the mediastinal gland; (e) chronic aortitis with coronary sclerosis; (f) cardiac dilatation and hypertrophy; (g) chronic cholecystitis and cholelithiasis; (h) chronic nephritis; and (i) possible "adrenal rest"—or malignant growth—on the surface of the left kidney.

The microscopic findings substantiated the diagnosis of primary papillary carcinoma of the ureter with metastases to the left kidney, liver, right lung and mediastinal nodes. (Figs. 6, 7 and 8.)

DISCUSSION

Although this tumor was originally discovered at autopsy by Rayer, in 1841, only seventeen cases had been recorded by 1916. The data of large medical centers would label this lesion as a rarity. Thus one finds the Brady Urological Institute reporting three in a series of 22,000 cases, Bellevue

one in 22,000, Ohio State University Hospital one in 7,700 cases and Vienna Anatomical Institute four in 13,854 cases (Renner).

3. Mixed (1 and 2), (Adler—Pope).
4. Nonepithelial, (fibroma, sarcoma, etc.).

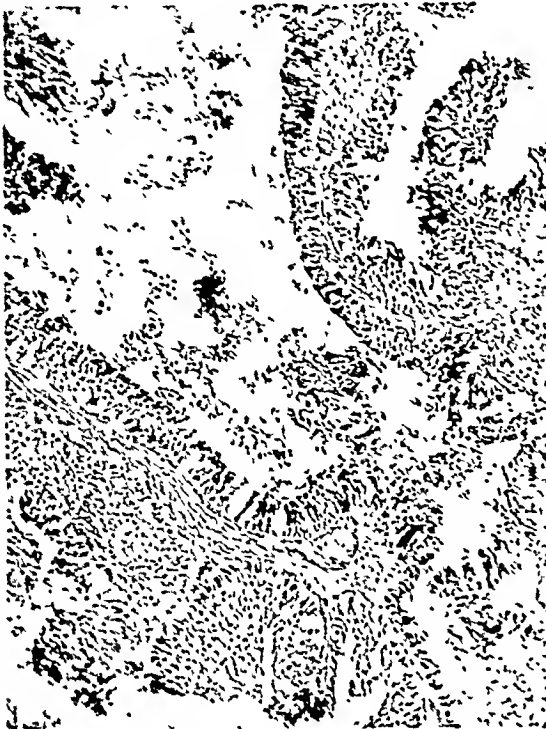


FIG. 6. The high calibre epithelial cells which compose the tumor can be seen arising from the central core of connective tissue.



FIG. 7. Section from the left kidney showing the papillomatous structure of the carcinoma, occupying the upper two-thirds of the field.

Nevertheless, the number of recorded cases have reached a total of nearly 150, of which two-thirds have been added in the past eight years. At present, an additional eighteen cases are being studied at the Mayo Clinic. The question arises as to whether this represents an actual increase in the incidence of ureteral neoplasms. Braasch views this number as "indicating an increase of interest in the condition rather than an actual increase in the frequency of its occurrence."

PATHOLOGY

Comprehensive descriptions have been made by others (Aschner, Joly, Lazarus, Scott, etc.). The transitional epithelia of the ureteral and vesical mucosa are the same. Consequently ureteral growths simulate very closely the pathologic groups of bladder tumors. These types are:

1. Papillary, single and diffuse.
2. Nonpapillary, single and diffuse.

Studies of extensive series reveal the following incidence: Papillary group, 45 per cent (Joly); 40 per cent (Higgins); non-papillary group, 42 per cent (Lazarus).

Usually situated in the lowest segment of the ureter, these tumors occur equally on both sides and with no predilection for either sex.

The only series to be studied from the point of degree of malignancy is reported by Braasch as follows:

	No. of Cases	Per Cent
Group I.	1	6
Group II.	7	42
Group III.	7	42
Group IV.	1	6

The proportion of ureteral tumors to pelvic (renal) tumors is 1:5 (Joly).

Metastasis is frequent (48 per cent—Higgins), and occurs chiefly via the re-

troperitoneal lymphatics, although blood stream invasion may be seen. Hinman notes as frequent sites of metastases the kidney and liver.



FIG. 8. This section shows lung metastases. In the center a blood vessel filled with a malignant thrombus is noted. Other areas of malignancy can be seen in adjacent tissues.

In the pathogenesis of these tumors, the following postulates have been advanced: (a) Leukoplakia (Aschner); (b) mechanical irritation by calculi; (c) inflammatory irritation; and (d) embryonal cell rests in the ureter, usually associated with a non-papillary tumor (Rusche and Bacon).

This neoplasm occurs most frequently between the fourth and seventh decade of life, although cases in the second and third decades have been recorded.

Diagnosis has been based on the classical triad: of pain, hematuria and a mass. Pain present in 60 to 65 per cent of all cases has been either costovertebral distress or severe lancinating pain in the lower lumbar and sacral regions. The latter type indicates a grave prognosis, as it invariably is associated with invasion of adjacent tissues. Hematuria (70 per cent) is, according to

Higgins, more pronounced in papillary tumor rather than squamous cell carcinoma. A mass may either be of a renal (hydronephrosis) or ureteral origin. The latter may be palpable per rectum or vagina and is also an indication of adjacent tissue involvement.

Certain other urological data have been suggested, such as, (1) presence of a tumor at the ureteral orifice (30 per cent); (2) ureteral catheter manipulation resulting in profuse bleeding; (3) ureteral catheter manipulation resulting in bleeding at the site of tumor, with clear urine above it; and (4) ureterogram, exhibiting either a filling defect in the form of a narrow or wide ring-like obstruction, a papillary or olivary outline or a ragged, moth-eaten appearance (limited and diffuse).

In spite of the above clear-cut symptoms and signs, extensive series show preoperative diagnoses to have been made only in about a third of the cases (Lazarus 38 per cent, Scott 36 per cent). In small series (eighteen cases) Braasch reports a 60 per cent incidence.

To increase this proportion, careful ureterogram studies have been suggested, not only in the usual anterior, but also lateral positions, employing some iodized oil, followed by injection of air, as in cystographic technic.

Differential diagnosis offers an interesting study. A true ureteral neoplasm must be differentiated from: (1) Hemangioma (Caulk, Braasch); (2) granuloma (Braasch); (3) lymphatic infiltration of the ureteral wall. The case of J. A. Magoun was characterized by a typical blood picture of leukemia. A regression of these infiltrated areas and the associated hydronephrosis followed deep x-ray therapy. (4) Peri-ureteral growths, with secondary invasion; and (5) associated soft non-opaque calculi.

TREATMENT

Nephro-ureterectomy with excision of adjacent bladder wall is the accepted treat-

ment. Foord and Ferrier have found a two-stage procedure safest, with a 5 per cent mortality (twenty-two cases), in contrast to the one-stage with 40 per cent mortality (forty-four cases).

In view of the lesion's poor prognosis, preoperative irradiation should be strongly considered. Postoperative irradiation has been suggested for the excruciating pain of metastasis.

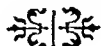
Prognosis is very poor. Braasch has found few to survive three years. Scott discovered only two patients alive after a five-year interval. However, several unusually good results have been reported, such as an eleven-year old cure (Kraft) and one eight years (Crance and Knickerbocker). B. A. Thomas successfully resected the involved portion of the ureter with re-implantation into the bladder.

CONCLUSIONS

1. A case of primary ureteral carcinoma, revealed by routine urologic survey, is reported.
2. Extensive metastases to lungs, mediastinal glands and left kidney occurred during a brief period of observation.
3. The initiating symptoms were two attacks of renal colic associated with some urinary pus and red blood cells. When the colic subsided, the urine contained only 1-2 red blood cells.
4. All cases of so-called simple kidney colic should be thoroughly investigated as to etiology.

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FIBROSARCOMA OF A POLYCYSTIC KIDNEY WITH EXTENSION INTO THE VENA CAVA*

REPORT OF CASE WITH SUCCESSFUL SURGICAL REMOVAL

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THIS is a presentation of a case of fibrosarcoma in a polycystic kidney with successful surgical removal. The tumor had grown until it filled the renal pelvis, completely occluded the renal vein and extended about 10 cm. into the vena cava. The kidney and extension of the tumor were successfully removed and the opening in the vena cava sutured. This patient was well three years and five months after the operation.

CASE REPORT

A woman, aged 46 years, was first seen March 2, 1933, complaining of blood in her urine, which had been present intermittently for the past three months. She had been operated upon four years previously for removal of a cyst of the liver. Palpation of both kidneys during this operation revealed bilateral polycystic kidneys.

When first seen by us, both kidneys were easily palpated and were somewhat enlarged, firm, nodular and irregular. The right kidney was slightly larger than the left. Urinalysis revealed some albumin, pus and blood, with a specific gravity of 1.012. Examination of the blood showed 88 per cent hemoglobin, 4,700,000 red cells, and 6,200 white cells, with a normal differential count. The phenolsulfonphthalein (intramuscular) output was as follows: first half hour, 2 per cent; second half hour, 5 per cent; third half hour, 10 per cent; fourth half hour, 8 per cent; third hour, 5 per cent. The total amount secreted was 30 per cent in three hours. The blood sugar determination showed 102 mg. per 100 cc.; the blood uric

nitrogen was 10 mg. and the creatinine 1.2 mg. per 100 cc. Cystoscopy revealed blood spurting from the right ureteral orifice. The divided renal function was almost equal from each kidney. The pyelogram showed a filling defect in the lower calyx of the right kidney pelvis. (Fig. 1.) Removal of this kidney was advised but was refused by the patient.

On May 15, 1933, the patient returned, passing blood in her urine with some clots. The general examination revealed no marked change. Another right pyelogram was made, which showed an increase in the size of the filling defect in the lower renal calyx. (Fig. 2.) Surgical intervention was again refused. Following this cystoscopy, the hematuria ceased for almost a year.

The patient was next seen August 12, 1934, still complaining of intermittent hematuria as the only symptom. There was little change in the size of her kidneys at that time. The urine showed both pus and blood. Examination of the blood revealed 75 per cent hemoglobin and 3,850,000 red cells. Cystoscopy again proved the blood to be coming from the right kidney. No phenolsulfonphthalein was collected from the right kidney in fifteen minutes after intravenous injection, and only 5 per cent from the left ureteral catheter. However, there were 6 Gm. of urea per 100 cc. from the right kidney and 7 Gm. from the left. The pyelogram showed an increase in the filling defect in the right kidney pelvis. (Fig. 3.) Surgery was again advised and refused.

One month later she returned with a chill, nausea, vomiting and a dull ache in the right loin. At this time her urine contained considerable pus and colon bacilli with some red

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Read before the Section on Genito-Urinary Surgery of the New York Academy of Medicine, February 21, 1940.

blood cells. Her blood chemistry remained normal, but her blood count showed only 2,500,000 red cells with 60 per cent hemoglobin.

This patient was not seen again until September 18, 1936, more than two years later. She had had intermittent attacks of hematuria



FIG. 1. Right pyelogram of polycystic kidney showing a filling defect in the lower renal calyx, March 2, 1933.

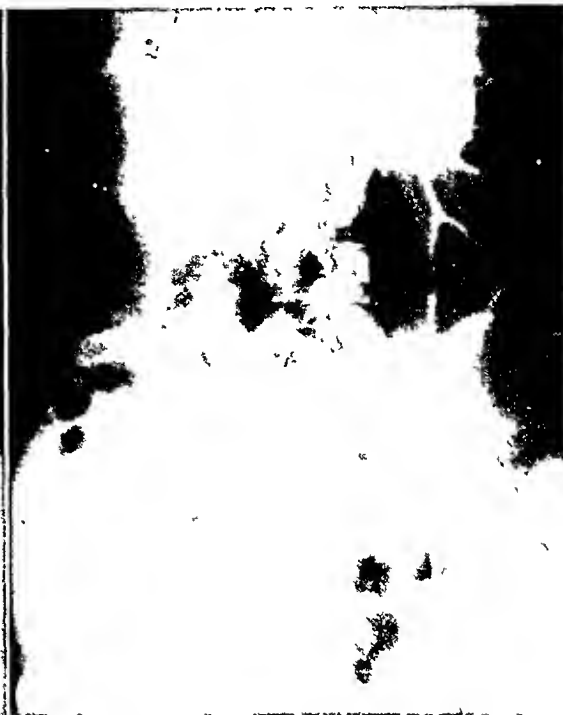


FIG. 2. Right pyelogram of same kidney taken two months and thirteen days later. Note increase in size of the filling defect, May 15, 1933.



FIG. 3. Attempted right pyelogram in same case fifteen months later. All renal calyces and the upper ureter are obliterated. No change in left pyelogram, August 12, 1934.

A catheter was inserted into the right kidney pelvis and irrigated at intervals for forty-eight hours. Her temperature, which was 104°F. on admission, gradually subsided to normal. Again surgery was refused.

and recently had noticed a mass in her right upper abdomen, which had progressively increased in size. She had gained weight during the past few months and complained of no other symptoms. Examination showed a large

irregular mass almost filling the right half of the abdomen. There were a few superficial, prominent veins over the right abdomen.

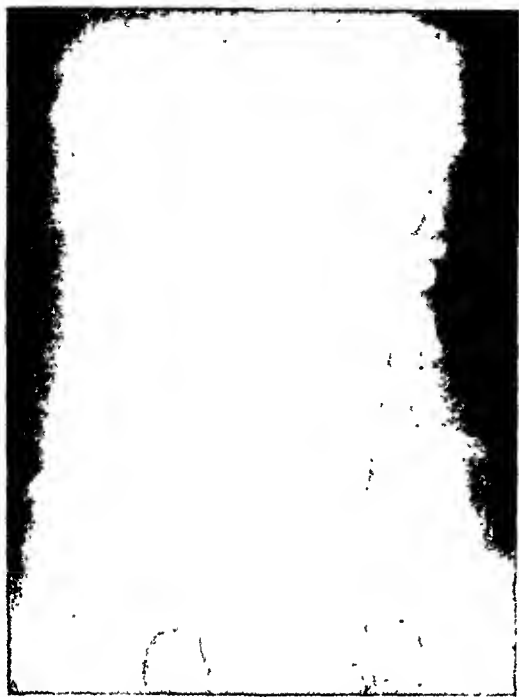


FIG. 4. Right ureteral catheter met an obstruction half way up the ureter. A tumor mass on the right side has diverted the catheter medially. No contrast media could be injected. Diagnosis: large right renal tumor. This film taken twenty-five months after Figure 3, September 22, 1936.

Cystoscopy revealed a functionless right kidney. The right ureteral catheter met an obstruction half way up the ureter. An attempt to inject contrast media into the right renal pelvis failed. The roentgenogram showed an obstructive filling defect in the upper ureter and pelvis. (Fig. 4.) The entire right half of the abdomen was filled with a mass which caused the ureter to be diverted medially. Urine from the left kidney was normal and its function was adequate, though diminished. Chest x-rays showed no evidence of metastases. The blood pressure was 125 systolic and 85 diastolic.

Operation. On September 23, 1936, the right kidney was removed through the usual lumbar incision. The kidney was freed with considerable difficulty. A hard, round mass could be felt extending down the renal vein into the vena cava. In clamping and tying the renal pedicle, this mass was broken off, leaving the distal portion of the tumor in the renal vein. The kidney was removed. The remaining

tumor was palpated. It extended into the vena cava and almost occluded it. Ellis clamps were placed around the short stump of the renal vein. The tumor mass was carefully separated from the wall of the vein. Some bleeding occurred during this dissection, and a smooth clamp was held in readiness to clamp the renal vein when the tumor was removed. By careful manipulation, the tumor mass was delivered from the vena cava and, to our surprise, no bleeding occurred. The blood in the vena cava could be seen swishing back and forth but with insufficient pressure to force it out the opening into the renal vein. Four mattress sutures of No. 0000 chromic catgut on an atraumatic needle closed the opening. Retroperitoneal fat was pulled over this area and sutured to the muscles on the opposite side of the vena cava. Two Penrose drains were placed to the pedicle and the wound closed in the usual manner.

The patient was kept on her left side for twenty-four hours. The dressings were only slightly blood-tinged for forty-eight hours. A transfusion of 500 cc. of blood was given, and convalescence was uneventful.

Pathological Report. The pathological diagnosis was polycystic kidney and fibrosarcoma of the kidney. Gross description: The specimen consists of a right kidney and tumor mass, the whole measuring about $23 \times 18 \times 12$ cm. (Fig. 5.) At the upper end of the specimen there is a mass of renal tissue which measures about $11 \times 8 \times 9$ cm. Most of the surface of this kidney is occupied by cysts which vary in size from 0.1 or 0.2 cm. in diameter to 3.5 cm. A few cysts are also scattered over the remainder of the specimen. On the whole, however, the lower part is solid and of relatively smooth surface except for some few coarse lobulations. The stump of the ureter measures about 6.5 cm. in diameter. The extrarenal part of the pelvis is enlarged but its lumen is occupied by a solid mass. What appears to be the renal vein is dilated by a mass of somewhat friable yellow tissue. This has been broken across. Its continuance is represented by a separate mass of tissue which measures about $10.5 \times 5.5 \times 3.5$ cm. It is irregularly tongue-shaped and has a smooth and glistening surface. Its point of attachment to the mass in the renal vein measures about 2.3 cm. in diameter. Its cut surface is homogeneous, grayish yellow and translucent. On section, a communication may be found between a dilated calyx in the renal

tissue and the pelvis of the kidney, which is very much distorted due to the pressure of the large mass. The renal tissue is reduced to the

which are not unusual except for some dilatation. In other places the tissue is compressed by the presence of cysts lined by flattened



FIG. 5. Right kidney specimen showing fibrosarcoma in a polycystic kidney. Note remaining cysts in the upper portion of the kidney. The lower two-thirds and the renal pelvis are filled with tumor. The portion marked v extended into the renal vein and vena cava and should point cephalad.

thickness of tissue paper in most places due to the large cysts, most of which do not communicate with the renal pelvis. There is one area of the kidney in which some parenchyma remain, although this is honey-combed by small cysts. The cut surface of the tumor is in part light orange or pink, relatively soft and in part lighter yellowish white and fairly firm. In addition, in one area there is a very dense core of tough fibrous tissue which sends radiating strands into the surrounding tissue. Scattered areas of opaque, soft yellow tissue are found throughout the tumor. A few fair-sized blood vessels are present, but little, if any, evidence of hemorrhage except beneath the capsule.

Microscopic description: Sections of the renal substance show many glomeruli which are not remarkable in appearance and tubules

epithelium. There is an increase of fibrous tissue and some thickening of capsules of Malpighian corpuscles. There are a few deposits of calcium. Tubules are atrophic. Sections of the tumor present a fairly uniform appearance except for some areas of necrosis and edema. The nuclei of the cells vary in shape from rounded to oval to an irregularly elongated or spindle form. (Fig. 6.) They are quite uniform and finely vesicular without hyperchromatism. Mitoses are seen, but are not numerous. The cytoplasm of the cells is usually not sharply defined. In places, especially where the tissue is somewhat edematous, processes may be recognized coming from the cells. In addition, there are scattered throughout other smaller cells not unlike small lymphocytes in appearance. Nowhere is there any suggestion of gland

structure, although in many places the cells are arranged radially about thin-walled blood vessels in rosette formation. With Van Gieson's

blood clot from a bleeding polycystic kidney might have given a similar appearance in the pyelogram. The patient had

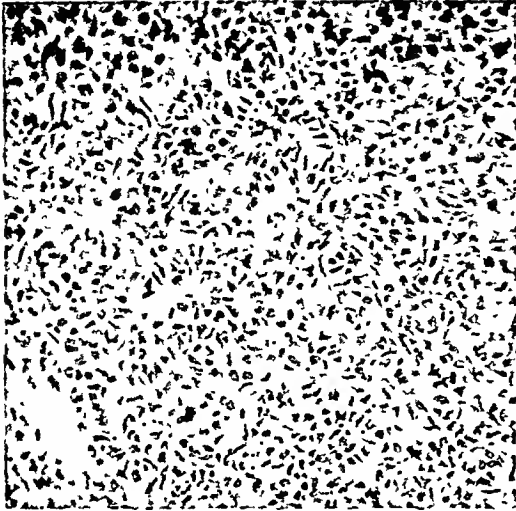


FIG. 6. Section through the tumor showing a large number of spindle-shaped and oval cells characteristic of fibrosarcoma.

connective-tissue stain many delicate, collagenous fibers are seen throughout, extending between the cells. Some of the fibers appear to be continuous with the cytoplasm of the cells. Sections prepared by Cajal's and Hortege's methods show no cells which can be considered as nerve cells. A section of the mass from the vena cava shows the same microscopic picture as the rest of the tumor. Its surface is covered by a small amount of connective tissue. The tumor appears to be of connective-tissue origin and of only moderate histologic malignancy, though slowly compressing and invading in its growth.

An excretory urogram was taken fourteen months later. (Fig. 7.) The size of the left kidney had not changed appreciably, and the kidney pelvis was the same as in previous examinations. This kidney is functioning adequately to permit the patient to lead a normal life as a housewife. Her general condition has been satisfactory, and there are no symptoms or findings suggestive of any recurrence or metastases.

COMMENT

This patient had been bleeding from this fibrosarcoma for more than three years before the tumor was removed. The cause of the bleeding was difficult to determine at the beginning of her symptoms, since a



FIG. 7. Excretory urogram of same patient fourteen months after removal of right kidney. Note no demonstrable change in size of left renal pelvis, November 15, 1937.

been operated upon in 1929 for the removal of hepatic cysts. During this operation both kidneys were palpated and found to be polycystic. The fact that polycystic kidneys were known to be present tended to cloud the diagnosis.

One opens the vena cava very reluctantly. However, Walters and Priestley have shown, both clinically and experimentally, that the vena cava can be sutured satisfactorily when it has been either accidentally torn or deliberately opened.

The most satisfactory method of closing a tear or incision in the vena cava is by careful suture, provided the opening is accessible. In order to prevent hemorrhage while the sutures are being placed, pressure is frequently required both above and below the opening. Walters and Priestley suggest the use of oiled silk sutures, and Charles Mayo has reported several such cases closed with silk impregnated with vaseline. In this case, no pressure was

necessary on the vena cava in order to prevent hemorrhage. Mattress sutures of No. 0000 chromic catgut on an atraumatic needle were apparently satisfactory when covered with a layer of retroperitoneal fat. Oiled silk has proved more successful in experimental work, and probably should be used.

In this case, the vena cava was almost occluded by the tumor. Had we failed to remove this tumor from the vena cava, the patient, in all probability, would have died shortly, either from complete occlusion of the vena cava, extension of the growth to the heart or embolism. Therefore, the added risk of removing the extension of this tumor was deemed justified. The lack of bleeding from the vena cava may best be explained by the fact that collateral circulation had relieved the vena cava of much of the usual quantity of blood carried by it. As the tumor gradually grew into the vena cava, the quantity of blood in the vena cava of necessity became diminished, and collateral vessels assumed part of its burden. Pressure in the vena cava is normally not great, and even this little pressure was probably diminished by the encroachment of the tumor in its lumen.

Fibrosarcomas of the kidney apparently metastasize late. This tumor was well encapsulated, and the surface of the portion in the vena cava had apparently not damaged the vessel wall. Its surface was smooth and glistening.

Removal of a polycystic kidney is rarely indicated. According to Rovsing, the life expectancy is shortened by such intervention. However, circumstances such as the one here described are sufficient to warrant surgical removal. The right kidney, invaded by tumor, was functionless and the renal burden had already been transferred to the left kidney. This patient is alive, well and free from symptoms, and as far as can be determined, is free from recurrence or metastases 3 years and 5 months after operation.

SUMMARY

1. A case of fibrosarcoma developing in a polycystic kidney with extension into the vena cava is presented.
2. The difficulties of accurate diagnosis are discussed since both polycystic kidneys and tumors frequently bleed.
3. Surgical removal by opening the vena cava is described and the vena cava closed by sutures.
4. The patient has lived three years and six months since operation which shows that a patient may live for some time with only one polycystic kidney.

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TOTAL GASTRECTOMY FOR LINITIS PLASTICA*

CASE REPORT

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THE operative mortality for total gastrectomy is high and is usually estimated to be between 40 and 50 per cent. Many patients, however, not only survive such extensive surgical procedures but they may live in comparatively good health for four or five years as reported in several instances, and eleven years in one case as reported by Leriche.¹

HISTORICAL CONTRIBUTIONS TO SUBJECT

In 1878, Kaiser² of Czerney's Clinic reported the results of experimental work on dogs. Of five animals in which almost the entire stomach had been resected, one dog survived for five years and was then killed and the specimen examined by Ludwig, the famous pathologist. It showed that a small piece of stomach wall remained at the cardiac end "which enclosed a spherical cavity filled with food." Physiologically, the dog appeared quite healthy, and the digestion seemed not to be impaired in any way.

Phineus Connor,³ of Cincinnati, in 1884, performed the first complete removal of the stomach in man. The patient, moribund at the time of operation, died on the operating table.

Thirteen years later, Schlatter⁴ performed a successful total gastrectomy in man and demonstrated for the first time that a human being could live without a stomach and that an anastomosis could be made between the esophagus and the jejunum. The patient, a woman of 56, survived one year and fifty-three days; she died of a recurrence of the carcinoma.

The following year, in 1898, two successful total gastrectomies were reported by

MacDonald⁵ and Brigham.⁶ The former's report did not indicate how long the patient lived after operation but merely stated that he left the hospital on the thirteenth day and did not suffer any complication other than diarrhea. Brigham's patient survived more than two years and he showed that hematopoiesis was not affected by such an operation. He anastomosed the esophagus and duodenum.

At a meeting of the Deutsche Gesellschaft für Chirurgie in 1898, a discussion arose as to just what constituted a total gastrectomy. Kronlein defined total excisions of the stomach as only those in which both the pylorus and cardia had been removed, and in which on examination of the specimen one should find a portion of the esophagus at one end and of the duodenum at the other. Finney and Rienhoff⁷ altered this definition and defined a total stomach excision as one which includes both the cardiac and pyloric sphincters; their reason for doing this is that occasionally gastric epithelium is found to extend proximal to the cardiac sphincter up into the esophagus and also into the duodenum.

Reid⁸ published a comprehensive report of a case in which he had performed successful total gastrectomy for a diffuse scirrhus carcinoma which involved all of the stomach except a small portion of the fundus. Grossly, the process was typical of linitis plastica or leather-bottle stomach. He concluded that this was the ideal lesion demanding a total extirpation of the stomach. The condition develops slowly; metastasis rarely occurs until the latter stages of the disease. It is the only possible operation that may result in a cure because as

* From the Jackson Clinic, Madison Wisconsin. Read at the Western Surgical Association Meeting, Los Angeles, December 16, 1939.

a rule the growth involves the greater portion of the stomach by the time it comes to the surgeon. The operation is compara-



FIG. 1. Preoperative x-ray, typical of linitis plastica.

tively easy to perform due to the shrunken condition of the stomach. With these conclusions I wish to concur.

Finney and Rienhoff from their study of sixty-seven case reports of total gastrectomy drew the following important conclusions: (1) In regard to the type of anastomosis, an esophagojejunostomy is to be preferred on the whole to an esophagoduodenostomy. (2) The operation should be carried through in one stage. In those patients in whom anastomosis was not performed at the primary operation, all succumbed, either by shock, peritonitis or both. (3) Patients as well as animals, when properly fed as regards consistency, amount, and periods of feeding, can get along without a stomach. (4) As far as pepsin and hydrochloric acid digestion is concerned, it has been shown that the physiologic digestion of protein, fats and carbohydrates is not seriously affected by the exclusion of these two elements of the gastric juice.

In 1933, Roeder⁹ collected all authentic total gastrectomies bringing the total to eighty-eight. Among the most recent re-



FIG. 2. Complete stomach removed and opened showing involvement from pylorus to cardia.

ports are those of Lahey,¹⁰ Clute,¹¹ Allen¹² and Walters.¹³ These surgeons have varied and improved the operative technic. There are probably other cases that have not as yet been reported.

My case report with a discussion of operative technic and postoperative care follows:

CASE REPORT

The patient, a maiden lady of 69 years, had complained of loss of appetite for about seven months. During this time she had lost twenty-two pounds in weight. For the last five months she had noticed a dull ache and distress in the epigastric region with a feeling of filling up rapidly. Belching would give some relief; there was no vomiting or hematemesis. Occasional spells of vertigo with a sense of the heart's stopping were present. Family and past histories were irrelevant. Physically, she was fairly well preserved for her age—rather tall and weighed one hundred forty-two pounds. A blowing systolic murmur was present at the apex. The abdomen was flat with no masses palpable; there were no enlarged lymph glands.

Urine was normal. Blood count showed hemoglobin 91 per cent; erythrocytes, 4,790,000; white blood count, 7,600; differential—81 polymorphonuclears; 13 lymphocytes; 5 transitionals; 1 eosinophile. The Kahn test was negative; blood urea 27 mg. Gastric analysis showed total acidity 12; no free hydrochloric acid at one and one-fourth hours; some mucous.

X-rays of the stomach and gallbladder were reported as follows: "Gallbladder functions

normally. There is a new growth in the middle third of the stomach of a bizarre type resembling linitis plastica except that the pre-

point I applied a Dixon colon clamp to the esophagus and cut the esophagus off just before it enters the stomach. The gastrosplenic vessels



FIG. 3. Four weeks postoperatively well functioning esophagojejunostomy.

pyloric antrum appears to have a normal elasticity. It is doubtful that this lesion is resectable."

The patient was hospitalized on August 31, 1939, for preparation and operation was performed by the author on September 5, 1939 under spinal anesthesia. A Marweedal left rectus incision was used which gave an excellent exposure of the stomach. The diagnosis of linitis plastica with a leather-bottle type of stomach made by the roentgenologist was immediately confirmed on inspection and apparently there was no metastatic involvement or evidence of extension to other organs. There was an isolated cystic mass about 3 cm. in diameter in the right lobe of the liver. It was readily seen that only a complete gastrectomy could give any hope of cure. The duodenum was severed one-half inch distal to the pyloric sphincter and the stump inverted with two layers of chromic and additional interrupted silk stitches. The greater portion of the gastrohepatic and gastrocolic omentum were removed with the stomach as well as the greater omentum. When the coronary artery was ligated at the axis, the esophagus was found to be elongated to the extent of some 4 to 5 cm. At this



FIG. 4. The patient four weeks postoperatively.

were ligated and the stomach removed. I then brought a loop of the jejunum about five to six inches long through the transverse mesocolon and had no difficulty in approximating the upper end of this loop to the open end of the esophagus.

The anastomosis was made in an isoperistaltic direction by first placing stay sutures of silk and then a continuous posterior row of silk. An inner layer of continuous chromic closed the opening and the posterior layer of silk was continued around as in the ordinary gastroenterostomy. Re-enforcement with interrupted silk was then applied around the anastomosis. The transverse mesocolon was attached to the esophagus by a few stitches of interrupted silk. A Lavine tube was then guided between the fingers into the distal loop approximately three inches beyond the anastomosis. A simple enteroenterostomy was now performed between the loops of jejunum at the lower-most point. The abdominal wound was closed with continuous and interrupted chromic, figure of eight silkworm, and dermal sutures in the skin. 500 cc. of citrated whole blood was given to the patient postoperatively. The patient suffered no shock from the operation and on her return to bed temperature was normal, pulse 100 and respirations 20.

Sections from the whole length of the stomach were removed for pathological examination and the report is as follows: 1. "Pyloric sphinc-

ter portion—suggestive of invasion of small cell carcinoma. 2. Pylorus—small cell diffusely infiltrating carcinoma of muscularis but not mucosa. 3. Lower portion of stomach—diffusely infiltrating small cell carcinoma. 4. Upper portion of stomach—carcinoma infiltrating all layers. 5. Cardiac end of stomach—shows marked infiltration with carcinoma. 6. Lymph node from lesser curvature shows extensive metastasis. Diagnosis: Diffuse small cell highly anaplastic carcinoma of the stomach. Note: All sections showed cancer. Linitis plastica in most cases is highly anaplastic small cell carcinoma diffusely infiltrating."

During the first four postoperative days she required very little sedative, her water balance was maintained chiefly by intravenous saline and glucose, and on the fourth postoperative day she was allowed water through the Lavine tube. On the sixth day the tube was removed, and the patient was allowed to take liquid nourishment from a special formula of predigested food. The wound healed by primary intention. Nourishment was given first at one-half hour intervals and later at one hour intervals. Except for a feeling of fullness following nourishment and some impaction in the rectum from the barium meal, she had virtually no complaints.

On the twentieth day she was allowed to walk and at that time was on two hour feedings consisting of scraped beef, potato, milk, gruels, etc., and apparently took care of the food without any difficulty. Her red cell count and hemoglobin were practically normal. Altogether her convalescence has been extremely satisfactory.

Allen and Walters advise a jejunostomy for feeding but this, I believe, is unnecessary. I believe the enteroenterostomy as a bypath for the bile is well worthwhile, although Lahey has discarded its use.

Approximately three and one-half months after operation the patient is on a five meal schedule with a more liberal diet and enjoys her food. There has been no diarrhea. Hemoglobin is 91 per cent and red cell count 4,990,000. Inasmuch as the patient's general condition is very good, I should say that her expectancy of life for a few years was excellent. We shall keep her under close observation and watch out for the secondary anemia which so frequently occurs following complete or almost complete gastrectomy.

CONCLUSIONS

1. The two ideal lesions for total gastrectomy are linitis plastica and ulcer high on the lesser curvature.

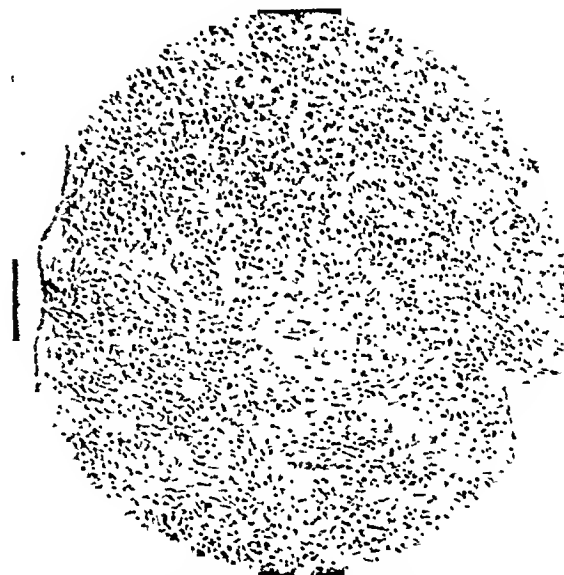


FIG. 5. High power. Diffuse small cell highly anaplastic carcinoma of stomach.

2. The Dixon colon clamp for holding the cut end of the esophagus greatly facilitates the performance of the anastomosis.

3. Jejunostomy for feeding purposes is probably not necessary if the Lavine tube is guided into the distal loop well beyond the anastomosis.

4. Jejunojejunostomy serves a useful purpose in providing a bypath for the bile and pancreatic juices.

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CHRONIC atrophic gastritis may develop from chronic superficial gastritis; it will be found in deficiency states such as pernicious anemia and idiopathic microcytic anemia. It is not impossible that lack of vitamins may sometimes play a rôle in the origin of this disease.

From—"The Practitioners Library of Medicine and Surgery" 1940 Supplement (D. Appleton-Century Company).

ECHINOCOCCUS CYST OF MUSCLE

REPORT OF A CASE OCCURRING IN THE LEFT PSOAS MUSCLE

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UNUSUAL and rare diseases, especially when they are met as a complete surprise, instill a new interest in the daily routine of the clinician.

Echinococcus infestation is rare in the United States and particularly so when the cyst has formed in muscle tissue. A patient recently seen by us in the out-patient department of St. Lukes Hospital, presented an interesting problem in differential diagnosis as well as this unusual location of an echinococcus cyst.

CASE REPORT

J. C., an Italian white male of 47 years, was first seen in the out-patient department on April 11, 1937. He complained of pains all over the body, weakness, headaches, dizziness and a cough which had lasted all winter and was productive of purulent material. He had no chest pain and no night sweats. His weakness was so severe that he was unable to work. Even light work caused marked perspiration. Loss of weight was 18 pounds in eighteen months. The physical examination was essentially negative except for an occasional rale in the left hilus. There was also some tenderness of the large muscles of the back. The blood pressure was 130/80.

X-ray of the chest showed clear costophrenic angles; the diaphragm on the right was somewhat nodular. There was no evidence of free fluid in either pleural sac. The terminal bronchioles in the right lobe, lower portion, were dilated. The root shadows were moderately increased on both sides. There was evidence of old pathology along the first and second interspaces on both sides.

The clinical diagnosis was bronchiectasis and myositis.

The patient did not return until August 8, 1939, when he complained of low back pain and a mass in the left side which had been present for two years and was gradually increasing in

size. He was then referred to the urologic department. A large mass could be readily seen on the left side, apparently extending from the kidney region. It was not movable on respiration, was smooth, not tender, and a swelling visible in the left abdomen seemed to be a smaller projection from the main mass in the flank.

Retrograde pyelograms showed the left kidney larger than normal, with an opaque shadow opposite the transverse process of the second lumbar vertebra on the left side, apparently medial to the shadow of the left kidney. Irregular calcification led to the belief that it was due to a calcified lymph gland. The pelvis and upper portion of the left ureter were displaced laterally and upward, and only a small amount of dye had entered the lower calyces. These were apparently cut off and it appeared possible that the mass was pushing the kidney upward. A diagnosis of tumor or large cyst involving the lower pole of the left kidney was made. On close scrutiny of the films the faint outline of a mass could just be discerned. (Fig. 2.)

A barium enema showed the mass definitely posterior to the descending colon. The colon was freely movable and could be separated from the mass.

The patient entered the hospital September 7. Urinalysis was negative. The blood showed 13 Gm. hemoglobin per 100 c.c.; red blood cells 5,300,000; leucocytes 5000; coagulation time 2.5; bleeding time 1.5. Differential count was: lymphocytes 24; monocyte 1; polymorphonuclear neutrophils 72; eosinophiles 3.

The diagnosis was not clearly established, but a retroperitoneal tumor or a solitary cyst of the kidney was considered most likely.

Exploration of the left renal area was performed after the usual oblique muscle-cutting loin incision. The mass was found to originate from and seemed firmly attached to the left psoas muscle. The normal left kidney could be seen above. We thought we were dealing with

a large retroperitoneal tumor which we considered inoperable. However, an incision to remove a portion for microscopic diagnosis

continued chest complaints with unchanged physical and x-ray findings. The roentgenogram also reveals a large smooth liver shadow and the



FIG. 1. Left pyelogram showing relation of mass, which has been retouched, to the left kidney.

caused numerous daughter cysts to be extruded from the mass, and the opening was therefore enlarged so that the cyst contents could be evacuated. Then the entire cyst wall was mobilized and removed in toto. The pathologic report revealed echinococcus cyst of the left psoas muscle. (Fig. 2.) The wound was closed, leaving ample space for drainage.

The postoperative course was mild and the patient left the hospital September 24, feeling better than he had for a long time. He was seen in the out patient department and an intradermal test (Casoni) was performed. Blood was withdrawn for a complement fixation test, but both of these proved negative.

Further questioning elicited the fact that the patient was born and lived for the first thirteen years of his life in a large town in Italy. He was then brought to America and the rest of his life has been spent in New York City and Chicago. He had never spent any time on a farm and his family never kept dogs as far as he could remember.

Further observation is being carried on in the out-patient department because of con-

possibility of involvement of the liver and lungs must be considered.

Etiology. Echinococcosis in human beings is caused by infestation with the *Echinococcus granulosus*¹ or dog tape worm in its larval form. Human beings are only accidentally an intermediate host and constitute a blind pocket as far as further dissemination is concerned. The dog, wolf, and jackal are the ideal definitive hosts and they infect the food and water supply of the intermediate hosts by fecal contamination.

The ovum passed by the dog, when swallowed by the intermediate host, passes into the duodenum where its chitinous shell is digested. The embryo attaches itself to the mucosa by its hooklets and penetrates it. The embryo is then carried passively until it lodges in one of the capillary filters or passes through them to the organ in which it locates. The first filter is the liver; the second the lung.

The embryo may be destroyed or it may develop into an echinococcus cyst. The cyst has a definite laminated outer layer or ectocyst, an inner germinal layer which develops the brood capsules, the endocyst and a capsule or pericyst which is derived from the tissues of the host. The scolices, which are the heads of future worms, develop inside the brood capsules. Portions of the germinal layer may become separated, forming daughter cysts.

When a cyst containing viable scolices is ingested by the dog, wolf, or jackal, the scolices become attached to the wall of the intestine and develop into complete worms.

Occurrence. Hydatid disease is of rare occurrence in North America. Riley² states that up to 1933 approximately 430 cases were seen in the United States and Canada. Practically all of these were in individuals of foreign birth. In 1921 Magath³ reported twenty-five cases seen at the Mayo Clinic, four occurring in patients American born.

The localization of the cysts is accounted for in the life history of the embryo in the intermediate host, the sites of most frequent occurrence being the liver and then the lung, because of the filtering effect of these organs.

Devé,⁴ in reporting 2,727 cysts, gave the percentage occurrence as follows: liver 76.6; lung 9.4; muscle and cellular tissue 5.2; kidney 2.3; spleen 2.1; and bone 0.9.

In Magath's report of twenty-five cases seen at the Mayo Clinic and eighty-seven cases collected from the literature after 1902, one cyst of muscle was found in the anterior abdominal wall with cysts in the liver as well, and two were retroperitoneal.

Kneebone,⁵ in a survey of sixty cases in Australia, found three localized in muscle, one of them in the left psoas muscle.

Diagnosis. To diagnose the presence of echinococcus cyst clinically before surgical exposure, the possibility of its occurrence must, of course, be thought of. Specific tests for the presence of echinococcus cyst are not infallible. The precipitin test using the patient's serum and prepared hydatid fluid is positive in 65 per cent of cases.⁶ The

complement fixation test using a procedure similar to the Wassermann technique is positive in 52.4 per cent. The cutaneous

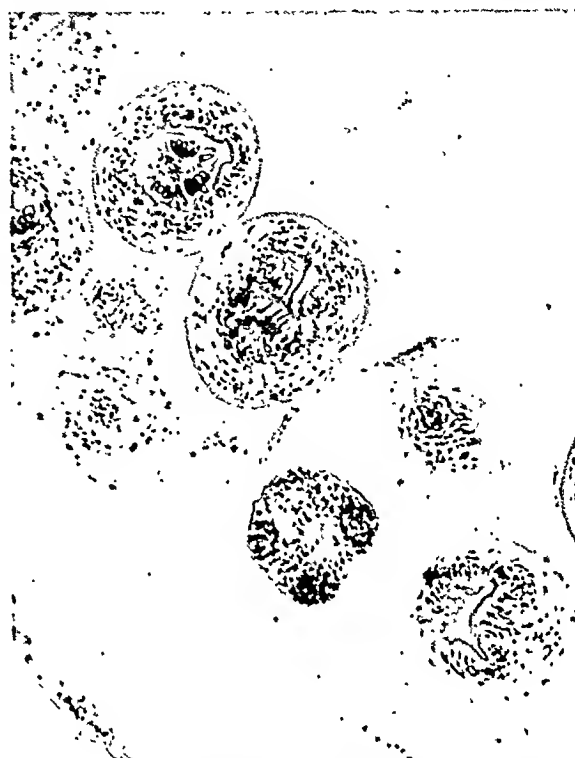


FIG. 2. Photomicrograph of scolices showing rostellum of hooklets.

test, similar to the Mantoux, injecting 0.2 c.c. of hydatid fluid intracutaneously, is positive in 56 per cent of the cases. Some reliance can be placed on an eosinophilia if other causes can be ruled out.

It may be possible to demonstrate the cyst roentgenologically. The pericyst derived from the host tissue may cast a shadow, depending upon the organ involved. The ectocyst with its contained fluid may cast a shadow like any cavity containing fluid. The endocyst does not cast a shadow. If the cyst dies, calcium is deposited in its wall and a definite shadow may then be shown.

The combination of the various laboratory tests and x-ray will allow a positive diagnosis of echinococcus cyst to be made in approximately 90 per cent of cases.

SUMMARY

Infestation with the echinococcus granulosa is uncommon in this country and the localization of a cyst in muscle rarely

occurs. This case is presented because of its clinical interest, and because of this unusual localization of the echinococcus cyst. In this instance the diagnosis was not made preoperatively, nor could it have been made even if considered, as the specific tests were found to be negative immediately after operation.

The entire cyst wall was removed at operation, and the patient's condition since then has been one of gradual improvement. Because of the chest findings and the enlargement of the liver, the patient is being kept under observation, but there has been no recurrence of the

condition either locally or in any other organ.

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Our view (regarding injuries of the liver) is that of Fairchild (1931) who classified injuries of the abdominal viscera as conditions which demand immediate exploration, on the basis of our inability to say that certain lesions do not exist rather than on our ability to say that they are present. From—"The Rôle of the Liver in Surgery" by Boyce (Charles C. Thomas).

TRAUMATIC RUPTURE OF THE LEFT LOBE OF THE LIVER AND RUPTURE OF THE LEFT DIAPHRAGM WITH LEFT CHYLOTHORAX*

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A TRAUMATIC rupture of the liver is one of the rarest surgical emergencies reported. According to Shedden and Johnson, rupture of the liver appears once in every 1300 cases admitted to the accident room of any large general hospital. Thorlakson and Hay reported eleven cases in 200,000 admissions over a span of twenty years at the Winnipeg General Hospital. In reviewing the available literature on this unusual injury, it was found that the right lobe of the liver was ruptured six times more often than the left. The spleen was involved in more cases than any other organ, and damage to the spleen was always associated with injury to the left lobe of the liver. The most common location is the posterior inferior surface of the liver. Jaundice is rare, and even then is noticeable only after several days. The real, or complete, ruptures of the liver are usually manifested by peritoneal irritation, which is caused by the sudden effusion of blood or bile into the peritoneal cavity. The mortality rate, as stated by Christopher, is 80 per cent for unoperative cases and 60 per cent for operative cases. In the literature the majority of the cases are of the subcapsular variety.

REPORT OF AN UNUSUAL RUPTURE OF THE LIVER

A white boy (L. I.) age 9 years, was hit by a speeding automobile about thirty minutes previous to admission to the emergency room of Aston Park Hospital. The child was in grave shock; the skin was cold and clammy and pulse

imperceptible. He was unconscious with respirations rapid and shallow. There was a deep jagged laceration of the scalp in the right occipital region and a large contusion in the right frontal parietal region. There were multiple abrasions of face, arms and legs. His right leg was externally rotated and a large contusion was in the right lumbar region. Both lungs were full of moist rales; temperature 97°F.

Treatment of shock was started but his condition appeared to be hopeless. His temperature remained at 97 degrees for the next six hours and then rose to 103.8 degrees. Twelve hours after admission he was still unconscious, his pulse was very weak and thready. A tentative diagnosis was considered at this time of (1) a severe head injury, (2) fracture of the right hip, and (3) possible internal injuries.

On the second day his temperature was 104 degrees; pulse rate 130 to 150. He was conscious but irrational and able to take fluids by mouth. There was slight epigastric fullness but no evidence of peritoneal irritation. There was a large ecchymotic area in the right lumbar region and moist rales at the bases of both lungs. A roentgenogram revealed an intertrochanteric fracture of the right femur with a free lateral fragment and marked rotation of the upper fragment with some overriding, and a chip fracture of the right transverse process of fourth lumbar vertebra.

On the third day his temperature was 101 degrees and pulse 120 to 130. His general condition had improved by the fifth day and his right leg was suspended in traction. On the seventh day he started to complain of pain in the left chest. A roentgenogram revealed no rib fracture but a general left pleurisy. The fullness in the epigastrium was increasing and on the eleventh day it had involved the upper ab-

* Presented before the Buncombe County Medical Society of North Carolina, October, 1939.

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domen down to the level of the umbilicus with an absence of resonance in Traube's semilunar area. A roentgenogram of chest on the twelfth

was soft and showed no signs of peritoneal irritation.

Thirty-second Day. His temperature was



FIG. 1. Large pockets of air in the abdomen after 500 cc. of bile colored fluid were withdrawn from the left pleural cavity and replaced by air.



FIG. 2. The stomach and duodenum pushed down to the left by these large pockets of air.

day revealed that there was a pleural effusion of the left chest.

Liver injury was considered on the thirteenth day; a slight icteric tinge of eyes was noted. Laboratory data at this time revealed icterus index of 20; two plus urobilin in urine; white blood count, 32,000 with 90 per cent polymorphonuclears; red blood count, 3,400,000, and hemoglobin 60 per cent.

Fourteenth to Thirty-first Days. The patient's pulse varied between 100 and 140; temperature 100° to 101°F.; respirations 24 to 28; icterus index 15 to 20. He was taking nourishment by mouth in small amounts and was having daily bowel evacuations. He complained of a great deal of upper abdominal pain that required opiates for relief. The superficial veins of the abdomen and chest were markedly engorged. This fullness in the upper abdomen was very disconcerting. It felt like a cystic mass; at times it would be very tense and then it would become soft. It would seem to be shifted more to the left of the midline and then at other times, more to the right. It occupied the epigastrium and upper abdomen, down to the level of the umbilicus. The lower abdomen

102.4 degrees, pulse 160, respirations 38 and shallow. His entire left chest was flat, except for a small area in the upper chest. There were moist rhonchi in trachea and moist rales throughout the right lung. Heart sounds were very weak. His upper abdomen, down to the level of the umbilicus was so tense that it looked as though it would rupture. The lower abdomen was soft with no signs of peritoneal irritation. The child's condition was extremely critical and death was only a question of time, unless something was done to relieve the pressure on his circulatory system. An abdominal approach was out of the question, and the safest procedure to give temporary relief from this back pressure on his heart was to do a thoracentesis of the left chest.

A needle, attached to a 50 cc. syringe, was inserted into the fifth intercostal space at the midaxillary line. To my great surprise, the first 50 cc. of fluid obtained had all the appearance of bile. The withdrawal of this bile colored fluid was continued until 750 cc. meters were obtained. Laboratory tests on this green fluid were all positive for bile. Following the withdrawal of this fluid from the left chest, it was noticed that the upper abdomen was not so

tense, his pulse dropped to 100 and respirations to 26. The following morning another thoracentesis was performed and 900 cc. of bile colored fluid obtained. Following the withdrawal of this amount, there was a decided change in the fullness of the upper abdomen. It was softer and a definite mass could be felt to the left of the midline.

It was very definite that there was some sort of communication of the left pleural cavity with the upper abdomen and liver. The next day (thirty-fourth day) the chest was again tapped. The fluid was still bile colored, 500 cc. were withdrawn and replaced with air. The child's hips and abdomen were raised on pillows so they would be higher than his chest. He was allowed to remain in this position for fifteen minutes and then a roentgenogram of chest and abdomen was taken, which showed large bubbles of air in the upper abdomen. (Fig. 1.) Barium was then given by mouth and the films showed the stomach and the duodenum pushed down and to the left. The colon was also pushed down but neither was involved. (Fig. 2.)

Each day a thoracentesis of the left chest was performed and an amount, varying between 500 and 750 cc. of bile colored fluid was withdrawn. The fullness of the upper abdomen corresponded with the withdrawal of the fluid from chest. The upper abdomen would be softer and a definite mass could be felt, more to the left of the midline, following the withdrawal. The patient's general condition was improving, his temperature varied between 99 and 100 degrees, pulse was below 120, was regular and of good volume. On the thirty-ninth day a plaster spica was applied to the right leg. A trocar was inserted into the fifth intercostal space of the left chest and through the lumen of this trocar, a rubber catheter was passed. The catheter was left in the chest with a stop-cock attached to its end. Five hundred cubic centimeters of bile colored fluid were withdrawn through the catheter before he was returned to the ward.

Fortieth to Sixty-ninth Day. There was a daily withdrawal of fluid through the tube and the daily amount varied from 300 to 1700 cc. The fluid was of a greenish color up until about the fiftieth day, when it changed to a yellow color. The total amount of this fluid, which was withdrawn from the left chest, was over 25 liters. The remarkable change was in relation to the fullness of the upper abdomen. It became

softer and then flat. The mass that had been previously palpated finally disappeared. About the forty-fifth day it was noticed that the child was passing clay colored stools.



FIG. 3. On the seventieth day in an upright position. The catheter in the left pleural cavity with very little free fluid and no fluid level. There were some small pneumothorax pockets at the apex and a large air pocket at the base; but it could not be ascertained if the pocket was above or below the diaphragm.

The plaster spica was removed on the seventieth day. A roentgenogram of the chest was taken with the child in an upright position. The film revealed very little free fluid and no fluid level. There was some pleural thickening and some small pneumothorax pockets at the apex, a large air pocket at the base, but it could not be ascertained if the pocket was above or below the diaphragm. (Fig. 3.) The child was then placed flat on his back and 500 cc. of yellow fluid were withdrawn from the chest or upper abdomen through a tube in his chest.

The child was examined under the fluoroscope on the seventy-first day. The diaphragm on the left was not recognized and there was a large bubble of air in the epigastrium. Barium was given by mouth and the stomach and duodenum identified, with a ring of air outlining the stomach. A roentgenogram of chest and abdomen, taken immediately after the fluoroscopy, showed this ring of air. (Fig. 4.) The withdrawal of fluid in small amounts continued up to the eightieth day, when it ceased entirely.

The last few days the fluid was a milky white, which was obtained in small amounts. It was centrifuged and the sediment was found to be

hospital ten days later (thirty-nine days after discharge). He was complaining of pain in the left upper abdomen with a temperature of 104



FIG. 4. Ring of air encircling the stomach.

numerous polymorphonuclear cells. The tube was removed and his temperature on this day was 99 to 100 degrees, pulse 100 and respirations 20. His general condition showed marked improvement.

From the eighty-first day until seven days before discharge from the hospital, he had a picket fence type of temperature, varying from 99 to 101 degrees. The last seven days in the hospital his temperature was at 98.6 degrees. The patient had no complaints and was rapidly regaining his weight and strength. The last two weeks in the hospital, the patient was allowed up and about the ward. On the ninety-sixth day another roentgenogram of the chest was taken, which showed no undrained fluid, but small pockets of air in the axillary area and some thickening at the base. The child walked out of the hospital on the one hundred fourteenth day.

He was seen again on the twenty-ninth day after discharge from the hospital. He had no complaints and had gained considerable weight. His temperature and pulse were normal. Liver edge was palpable about one finger's breadth below the right costal margin. This was not present on his discharge from the hospital. He was allowed to return home but re-entered the



FIG. 5. Illustration taken at patient's second admission to the hospital. Left diaphragm elevated and pleural thickening at the left base.

degrees, pulse 150 and respirations 40 to 50, short and shallow in character. He complained that when he took a deep breath it caused pain. There was spasticity of muscles and tenderness along the costal border in the left upper abdomen. Roentgenogram of chest and upper abdomen revealed that the left diaphragm remained elevated with much inflammatory process, largely pleural thickening at the left base. Nothing significant was seen in the abdomen. (Fig. 5.)

White blood count, 39,000 with 90 per cent polymorphonuclears, 7 per cent lymphocytes and 1 per cent myelocytes. The child's mother stated that she had noticed nothing unusual until the night before when he had a fever. He was re-examined several times that day and the only findings were the spasticity of muscles and tenderness in the left upper abdomen.

The following morning his temperature was 105 degrees and respirations 60. A pus pocket was suspected in the left upper abdomen and it was decided to do an exploratory laparotomy. Under general anesthesia, a left subcostal incision was made. Upon opening the peritoneum,

the stomach presented. When I tried to pass my fingers between the stomach and left costal wall, I encountered numerous fragile adhesions between the two. As I proceeded to gently release these adhesions, the patient collapsed and expired thirty minutes later. Permission for autopsy was granted and the essential findings are as follows:

The spleen was adherent to the lower surface of the left lobe of the liver. The spleen appeared to be swollen, round edged, though not perceptibly large. Its pulp was soft, bright red with numerous pale areas throughout. The right lobe of the liver was large; the left lobe was atrophied and firmly adherent to the diaphragm. On cross section the right lobe was congested; the left lobe showed virtually no functioning tissue. It was mottled with streaks of white and gray, representing what should have been liver tissue. The gallbladder was distended. Upon pressure, bile escaped freely into the duodenum. The left portion of the diaphragm was covered by the firmly adhering lower lobe of the left lung. When freed the diaphragm showed a crater-like opening with a diameter of 32 mm. and upon removing the diaphragm from the liver, this crater-like opening was freely recognizable upon the upper surface of the liver, the opening continuing into a tunnel leading through the entire depth of the left lobe, being covered below by the adhering spleen. The diameter of the tunnel on the inferior surface of the liver was 17 mm. There was no abscess detectable. Both lungs were adherent to the costal wall. On the right side the adhesions could be broken up with ease; on the left side the adhesions were very intimate and proceeded along all aspects, anterolateral and posterior in extent, as well as over the entire base. The right lung contained air throughout except for the posterior portion of the lower lobe, which showed the presence of beginning hypostasis. The left upper lobe contained air; the left lower lobe was contracted, apparently atelectatic, its size being approximately half of the normal.

SUMMARY

Reports of traumatic ruptures of the liver are not common and this case is most unusual, in that the original injury was a true rupture of the left lobe of the liver and rupture of the left diaphragm. The bile leaked down into the lesser omental sac as

well as into the left chest. The bile and exudate continued to collect in the lesser omental sac, forming a large tumor mass in the upper abdomen. The patient was discharged from the hospital on the one hundred fourteenth day and had apparently recovered. He was readmitted thirty-nine days later and died from operative shock during an exploratory laparotomy.

At autopsy an acute splenitis was found. The spleen was displaced from the splenic fossa and adhered to the inferior surface of the atrophied left lobe of the liver. There was a direct communication between the left pleural cavity and lesser omental sac by a tunnel passing through the diaphragm and the atrophied left lobe of the liver. I have been unable to find a similar case report in the available literature.

The roentgenograms were taken and interpreted by G. W. Murphy, M.D. There was a series of thirteen films but it was not possible to include all in this report, for the lack of space. The majority of the films were taken with a portable machine.

The autopsy and the microscopic tissue examinations were performed by Alfred Blumberg, M.D.

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EXPLORATION should be undertaken in every case of suspected liver injury in which the patient is not actually moribund, or in which he can be brought out of his shock and rendered reasonably fit for exploration. From—"The Rôle of the Liver in Surgery" by Boyce (Charles C. Thomas).

CONGENITAL OBSTRUCTION OF THE SMALL INTESTINE*

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CONGENITAL obstruction of the small intestine is not an uncommon condition and most authors who have written upon this subject have divided them into two groups; the intrinsic (atresias), and extrinsic (stenoses, peritoneal bands, intestinal malrotation, pressure from congenital tumors, cysts, etc.).

The case here reported belongs in the extrinsic group, for it apparently was produced during the stage of rotation and fixation of the viscera to the posterior abdominal wall by the fusion of their mesenteries with the posterior parietal peritoneum. During this, the last stage of the rotation, the lower portion of the duodenum is fixed and the duodenojejunal angle is formed. Apparently during the process of formation of this duodenojejunal angle, a band running from the parietal peritoneum to the mesentery crossing the superior mesentery artery produced this obstruction.

This patient had no other malformation in rotation. In other words, the intestines returned to the abdominal cavity and passed underneath the superior mesentery artery in the normal manner.

The jejunum, however, remained fused to the mesocolon which undoubtedly furnished a fixed point, and this, together with the firm band which formed apparently along with the superior mesentery artery, produced the obstruction that made surgery not only necessary but imperative.

Ladd¹ has discussed at length this and similar types of congenital obstruction of the small intestine. A case of duodenal obstruction by a constricting band was reported by Magendie and Pouyanne.² Roher, Roudil, and Courriades³ cited another duodenal obstruction which was caused by an abnormal hepatic pedicle.

The hepatic artery in their case ran from the superior mesenteric artery posterior to the duodenum, and the portal vein crossed the duodenum anteriorly at about the same region, thus creating a point of obstruction.

It might be noted that where the obstruction at the duodenojejunal junction is not complete, the patient may survive for many years. Madigan⁴ reported a patient, 30 years of age, who could never remember having had a spontaneous bowel movement. Apparently all his life he had evacuated the gastrointestinal tract by vomiting. X-ray examination revealed a hugely dilated stomach and duodenum, the second portion of the latter occupying the entire pelvis. This case, evidently, was one of almost complete obstruction in the third portion of the duodenum. Operation was not mentioned in the report.

These unusual case reports were noted by Jones.⁵

CASE REPORT

Baby C., female, was delivered on October 26, 1938, from a mother who was a rheumatic cardiac. No toxemic manifestations were noted.

Physical examination on the day of birth showed a small subconjunctival hemorrhage in the right eye, with slight scleral icterus. The skin was jaundiced and turgor was good. There were numerous small pustules on the face. No congenital deformities were noted. The birth weight was 7 pounds, 3 ounces.

About three days after birth the slight icterus had increased markedly and the child had developed a persistent, but not projectile vomiting. Breast feeding was abandoned and a formula adopted, but still the vomiting persisted and became aggravated. In five days the child had lost 1 pound in body weight. Jaundice increased in intensity, and a marked dehydration developed.

* Read before the Brooklyn Academy of Pediatrics, April 26, 1939.

On physical examination (fifth day) both ears were noticeably catarrhal. There were several white patches on the throat, probably

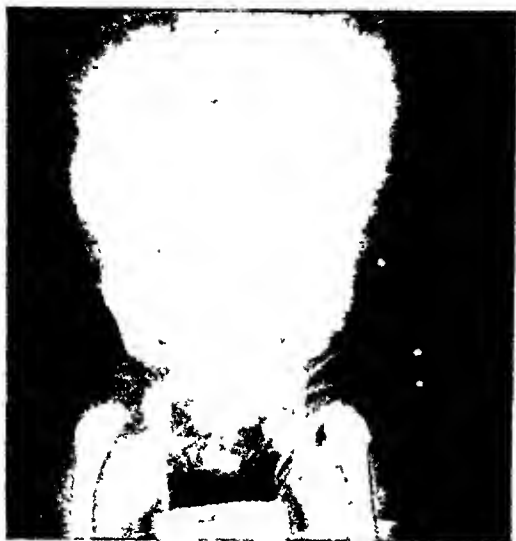


FIG. 1. Preoperative x-ray showing remnants of barium in stomach.



FIG. 2. X-ray three weeks after operation.

thrush. There was no nuchal rigidity. Respirations were shallow and slow and the breath sounds were considerably depressed. The abdomen showed a poor skin turgor, though it was soft, there were no masses palpable, and the liver and spleen were not palpated.

The child was first thought to have: (1) vomiting of undetermined etiology; (2) physio-

logic icterus; (3) dehydration. On the seventh day, it was noticed that the baby had developed an ashen pallor, was apathetic and would lie in its cubicle without moving. Vomiting had now become considerable, representing everything fed. There were stools, however. The abdomen showed some distention, but still no masses were palpated. A partial intestinal obstruction seemed likely.

Small feedings of a concentrated formula of similiae were given. The stomach was lavaged three times daily; supportive treatment was given with clyses (60 c.c., t.i.d.); atropine, $\frac{1}{1000}$ ten minutes before feedings was later increased to $\frac{1}{200}$; phenobarbital, gr. $\frac{1}{8}$ was administered ten minutes before meals—to no avail.

The white count was 11,500, with 52 per cent polys, 40 per cent lymphocytes, and 8 per cent monocytes. The red cells numbered 5,310,000; hemoglobin was 132 per cent. X-ray of the chest was negative, but the long bones showed



FIG. 3. X-ray five months after operation.

bands of increased density and rarefaction at the distal ends, suggestive of osteochondritis.

On the eighth day the child looked much worse. It now vomited bile-stained stomach contents continuously. The stools showed little fecal material. Gastrointestinal series revealed a complete gastric retention after twenty-four hours, and a diagnosis of pyloric obstruction of

congenital origin was made. At 4 P.M. of the eighth day the child was operated on under general anesthesia.

Both the stomach and the first and second parts of the duodenum were markedly dilated under a broad veil of adhesions containing the superior mesentery artery. The jejunum and the distal small gut were collapsed, the first part of the jejunum being fixed to the surface of the transverse mesocolon. A firm, thick, obstructing band was present at the duodenojejunal junction, for pressure on the stomach and pylorus failed to cause distention of the jejunum. A posterior gastroenterostomy was done, since it was deemed unwise to bring the jejunum over to the duodenum. This would have caused greater angulation of the first part of the jejunum. Two rows of atraumatic No. 00 sutures were used in the anastomosis. The resulting opening was large enough to admit the thumb. The abdomen was closed in layers and the child returned to the ward in fair condition.

Codeine gr. $\frac{1}{2}$, was given, with clyses of 60 c.c. three times daily and a continuous intravenous injection of 2½ per cent glucose at the rate of eight drops per minute.

At midnight of the day of operation the child began vomiting green-stained fluid continuously, and in the morning a Wangensteen drip was begun. A transfusion of 50 c.c. of citrated blood was given. Karo and water were given orally, gradually increasing from 1 minim every four hours to 5 teaspoonfuls on the following day. Maternal milk was increased from 1 teaspoonful half strength every three hours to 5 teaspoonfuls full strength on the following day.

The Wangensteen drip was continued for three days. At no time after operation did the temperature go above 99.6 degrees. The abdomen did not distend, the skin turgor began to improve, and the child seemed to show the first signs of improvement.

On the fourth day postoperative, the first

stool appeared black. Vomiting failed to occur even after the removal of the Wangensteen apparatus. The abdomen was soft and the child's condition rapidly improved as definite weight gain began. Feedings of maternal milk were increased rapidly and were reinforced with olac.

On the sixth day the child began having good bowel movements and the sutures were removed. Four days later the temperature rose to 103.6 degrees and vomiting of bile-stained fluid occurred, but this disappeared in a few hours.

On the day of discharge, November 23, 1938, twenty-eight days after admission and twenty days after operation, the baby had regained its total birth weight.

X-ray examination nineteen days after operation showed a free flow of barium through the enteroanastomosis.

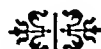
At six months the child was gaining weight, eating well, and its general condition was normal for its age. Two years after operation the child was normal and there were no gastrointestinal symptoms.

SUMMARY

1. A case of congenital obstruction at the duodenojejunal junction is reported.
2. Posterior gastroenterostomy was done in an eight day old infant with recovery.

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THE GASTROSCOPIC DIAGNOSIS OF PHYTOBEZOAR*

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GASTROSCOPY has made important progress as a diagnostic method since the introduction of the flexible gastroscope. Its clinical importance in the more common gastric lesions such as gastritis, ulcer and carcinoma has been reported in the voluminous gastroscopic literature of the past five years. Not so well known, however, is its value in the diagnosis of the rare or unusual gastric disease.

Until the advent of modern clinical gastroscopy, the x-ray was the only method commonly used to study the structural changes of the intact stomach. With gastroscopy and x-ray supplementing each other, but little gastric pathology need remain undiagnosed. In many cases the x-ray examination is sufficient for diagnosis. There are, however, cases where doubtful x-ray findings have been clarified by subsequent gastroscopy.

It is the purpose of this paper to illustrate this fact by presenting a case of phytobezoar diagnosed gastroscopically after clinical and x-ray examination had left the exact diagnosis uncertain.

In 1936 Moersch and Walter¹ reported the first case of phytobezoar to be seen through the gastroscope. A second case was reported by Ruffin and Reeves² in 1939. The case herein reported is the third one to be diagnosed by this method.

One hundred and twenty-six cases of phytobezoar have been reported in the literature, the last comprehensive report being that of DeBakey and Ochsner.³ These tumors are composed principally of seeds, skins and fibers of plants to which are adherent food particles, starch granules and muscle fibers. While many food materials will thus accumulate, in over 70 per

cent of the cases the mass consists of persimmons. The tumors are usually cylindrical or oval in shape, and vary in length from 4 to 12 cm., and in width from 2 to 6 cm. They may weigh up to 300 or 400 Gm.⁴ The dark brown or black surface may be smooth or pitted. The mass on first examination seems quite firm, but actually is quite friable and crumbles on slight pressure.

The presence of a phytobezoar should not be difficult to determine in most cases, but is often unsuspected because of the rarity of the condition. About 80 per cent of the patients present a history of having eaten persimmons, and inquiry into the previous eating habits will often elicit this information.⁵ Eighty per cent of the patients are of the male sex, and are above 30 years of age. A firm, freely movable abdominal mass may often be felt in the epigastrium, and can occasionally be displaced under the left costal margin. There may be some pain and slight tenderness, as well as nausea and vomiting. Weakness and loss of weight may be prominent, but constipation or diarrhea rarely occur. A slight secondary anemia and mild leucocytosis may be found. The gastric acidity is somewhat elevated, and there may be occult blood in the stool. There is no fever.

X-ray examination of the stomach with the barium meal will often help make the diagnosis.⁶ The barium may actually be seen displaced by the mass. Palpation will show the mass as movable within the stomach. Often the first swallow of barium is observed to diffuse slowly downward on either side of the tumor, outlining its shape. Similar x-ray pictures are presented by gastric polyps and the diagnosis of this condition is often incorrectly made.⁷

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Ulceration of the gastric mucosa is present in 23 per cent of the cases of phytobezoar.⁸ The high incidence of ulceration in these cases is probably associated with trauma to the gastric wall by the firm irregular edges of the foreign body. It is of interest that approximately 80 per cent of the gastric ulcers which occur in this condition are located on the lesser curvature. This figure is similar to that seen in gastric ulcers in general. If the ulcers associated with bezoar develop on the basis of trauma from the foreign body alone, they should develop equally often in other parts of the stomach. Since they do not so develop, it may be presumed that they are caused by the same underlying factors as ulcers uncomplicated by intragastric foreign bodies. The concept of a gastric pathway for the transference of gastric contents to the pylorus, along the lesser curvature, would seem supported by this fact. A foreign body would thus interfere with proper emptying of the stomach and would prevent the regurgitation of duodenal contents back into the antrum of the stomach. The failure in this fashion partially to neutralize the gastric acidity in this region might predispose to the formation of ulcer. The lesser curvature, which has an inherent vulnerability to the formation of peptic ulceration, would thus be the logical site for ulcer formation. While the presence of a bezoar may well be considered a predisposing factor to the formation of ulcer, there must be other precipitating causes not present in the great majority of cases, since in 77 per cent ulceration does not occur.

CASE REPORT

A cement worker, 53, entered the San Francisco Hospital, University of California, service of Dr. LeRoy Briggs, March 17, 1939, with the chief complaint of mid-epigastric pain of six weeks' duration. This had been dull, constant, but had gradually increased in severity until during the last week it became sharp, radiated to the lower left anterior chest, and was severe enough to awaken the patient from sleep. Anorexia, nausea and vomiting became increasingly prominent, and on one occasion the

vomitus was bloody. Exercise aggravated all the symptoms. Neither food nor alkali relieved them. A 5 pound weight loss resulted from the



FIG. 1. X-ray examination of the stomach showing large ulcer crater of lesser curvature in mid-portion of the stomach and a filling defect which might be a polypoid tumor or foreign body.

lessened food intake. Examination showed the abdomen to be slightly distended and soft. There was a hard, round, smooth, non-tender movable mass in the right upper quadrant, which measured approximately 10 cm. in diameter. A sharp, firm-edged spleen was easily palpable three fingerbreadths below the left costal margin. The liver, firm and non-tender, was palpable three finger-breadths below the right costal margin.

Laboratory examination yielded the following results: hemoglobin 14.6 Gm., R.B.C. 4,800,000, W.B.C. 6,050, with 72 per cent polymorphonuclears, eosinophiles 1 per cent, lymphocytes 18 per cent, monocytes 9 per cent. The urine was amber in color, cloudy, of alkaline reaction, albumin negative, sugar one plus, diacetic acid negative, acetone negative, bile negative. Wassermann and Kahn tests were negative. Icteric index 10.3. Serum albumin 3.49 Gm. per 100 c.c. Serum globulin 2.66 Gm. per 100 c.c. Takata-Ara test was positive. Stool examination showed: urobilinogen two plus and occult blood four plus. On gastric analysis, the fasting specimen, with histamine,

showed free acid 59 degrees, total acid 118 degrees.

X-ray examination (Fig. 1) by Dr. Lloyd

in diameter on the middle of the lesser curvature. The gastric wall on either side of this ulcer was considerably indurated and thickened.



FIG. 2. Gastrosopic view of lower third of stomach showing angulus, antrum and portion of pylorus. A benign ulcer is seen on the lesser curvature above the angulus.



FIG. 3. Gastrosopic view of mid-portion of the stomach. The third of a large phytobezoar is seen.



FIG. 4. Phytobezoar removed at surgery. It measured 9 by 5 by 6 cm. and weighed 129.5 Gm.

There was a rather large filling defect in the lumen of the stomach which appeared to move about as though it were a foreign body. Peristaltic waves passed freely over the distal part of the stomach beyond the site of the ulcer crater. No peristaltic waves were seen to pass through the region of the ulcer. The duodenal bulb filled and emptied well, and showed no defects of spasm. The impression was of a large ulcer of the lesser curvature of the stomach with infiltration of the adjacent gastric wall, possibly due to carcinoma. The gastric filling defect was apparently due to a foreign body. A tentative diagnosis was made of gastric ulcer, with possible carcinomatous degeneration. No decision was reached as to the exact nature of the foreign body.

On March 29, 1939, the interior of the stomach was examined by means of the Wolf-Schindler flexible gastroscope. Along the lesser curvature in the mid-portion of the stomach a sharp-edged gastric ulcer was seen which was definitely not malignant. This lesion measured approximately 1.5 cm. (Fig. 2.) Occupying the entire middle and upper third of the stomach was a large black shiny mass measuring approximately 5 by 9 cm. (Fig. 3.) The mucosa in this portion of the stomach appeared to be normal. A diagnosis of phytobezoar and associated lesser curvature ulcer was made. Following gastroscopy and a definite diagnosis, in response to particular questioning, the patient admitted eating a quantity of persimmons five months prior to the onset of his symptoms.

Bryan revealed a normal fundus of the stomach, but a large ulcer crater approximately 1.5 cm.

Surgical removal of the tumor was done by Dr. Clayton G. Lyon on March 31, 1939. The liver was moderately enlarged, dark in color, and studded with very small nodules. The parenchyma was exceedingly hard, and represented typical Laënnec's type of cirrhosis. Along the lesser curvature of the stomach, approximately 8 cm. above the pylorus, were several adhesions. This region was the site of an ulcer with a crater about 1.5 cm. in diameter. The tissues around the ulcer were quite hard and indurated, due to chronic inflammatory reaction. There were no metastatic lymphnodes.

The stomach was of normal size and showed no evidence of pyloric obstruction. The foreign body was palpated high in the cardia, and was then moved downward to the pylorus. The interior of the stomach was explored through an incision 5 cm. in length, made along the greater curvature, approximately 12 cm. above the pylorus. It appeared quite normal, except for the ulcer, which was definitely benign. The foreign body was then brought up into view and delivered through the gastrostomy opening. It was very dark brown in color, and measured 9 by 5 by 6 cm., a rounded, cylindrical structure, weighing 129.5 Gm. (Fig. 4.) The postoperative course was uneventful and the patient was discharged May 19, 1939, improved.

Pathologic examination showed that the specimen was a large mass of unidentified material, firm and uncoated. On microscopic examination, the mass of unidentifiable material appeared to be without structure or cellular detail. Because of the patient's occupation as a cement worker, an attempt was made to determine the presence of cement in the bezoar. A positive test for aluminum, present in cement, would confirm this possibility. Oxidation of a portion of the material with sulfuric and nitric acid and neutralization with ammonium hydroxide failed, however, to show a precipitate. The presence of cement was thus ruled out, and a definite diagnosis of persimmon phytobezoar made.

SUMMARY

The difficulties involved in the clinical diagnosis of phytobezoar are well illustrated by this case. Since the symptoms so closely simulated those found in other types of gastric pathology, it is not surprising that they suggested either gastric ulcer or carcinoma. An x-ray diagnosis was made of possibly malignant gastric ulceration and associated foreign body. However, the exact nature of the foreign body could not be determined. Gastroscopic examination made possible a positive diagnosis of phytobezoar and benign ulcer of the lesser curvature. These findings were confirmed by surgical and pathologic examination.

Since the submission of this paper, two additional cases of phytobezoar have been reported: Patterson and Rouse. Clinical use of the flexible gastroscope. *Texas S. M. J.*, 4:746, 1939; Browne and McHardy. Gastroscopy and the phytobezoar. *Arch. Int. Med.*, 65: 368, 1940.

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INJURIES TO THE DEEP AND SUPERFICIAL PERONEAL NERVES COMPLICATING ANKLE SPRAIN

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THE following three cases are presented because they deal with a rather simple clinical condition which is not at all common. In a cursory search of medical textbooks I have found only one reference. In Oppenheim's "Textbook of Nervous Diseases" translated into English by Alexander Bruce (1: 463, 1911) the author states, apropos of peroneal paralysis, "I have seen these symptoms develop after a sprain of the ankle." The Quarterly Cumulative Index Medicus from January, 1926 to date does not mention the subject, although it is possible that it may be dealt with in one of the various general clinical articles on ankle injuries. It seems that surgeons, orthopedists, and neurologists are not familiar with the fact that simple ankle sprain may cause injury to the deep and superficial peroneal nerves.

CASE REPORTS

CASE I. H. K., female, aged 26, in April, 1932, slipped on the polished floor in her home and turned her left ankle with the foot inverted, causing a severe sprain. She did not fall or strike any part of her left leg. The usual strapping was applied and for several days she had considerable pain and used a cane in walking. A week afterward she discovered that she could not lift her toes from the floor. This weakness reached its maximum in three or four weeks and there had been no improvement when she was first seen by me in July.

Examination showed atrophy and about 50 per cent loss of power in the left tibialis anticus muscle, slight weakness in extension of the toes of the left foot and a slight weakness of the peroneus longus and brevis muscles. There also was a decreased sensibility to light touch and pain on the dorsum of the left foot and the lower anterior and lateral aspect of the leg. Vibratory and position sensations were intact.

All the tendon reflexes were normal in both lower extremities.

The patient had a slight genu recurvatum and there was some hypotonia at both knee and elbow joints.

Faradic and galvanic responses were apparently normal in the weak muscles.

X-ray films of the lumbosacral spine and left knee region were negative.

Physiotherapy and the use of a device to offset the partial left foot drop were prescribed and there was complete clinical recovery by October 1, six months after the ankle sprain.

CASE II. L. L., female, aged 55, in February, 1936, tripped while walking in the street, lost her balance for a moment and sprained her left ankle, the foot being inverted and in extreme plantar flexion. She did not fall to the ground. By the time she got to the office of her physician, she noticed in addition to the usual discomfort of the sprain that there was a "numbness" on the dorsum of her left foot and that she was unable to extend the toes. The physician regarded the inability to extend the toes as a defense phenomenon associated with the swelling and pain about the external aspect of the ankle joint. Because the muscle weakness persisted after the sprain symptoms cleared up, the patient was referred to me.

Examination done about two weeks after the sprain showed a moderate weakness of extension of the left toes and foot and of ability to evert. There was flabbiness but no definite wasting of the tibialis anticus. Sensation and electrical reactions were normal. The ankle jerks were normal. The nerve trunk posterior to the lateral border of the neck of the fibula seemed to be tender.

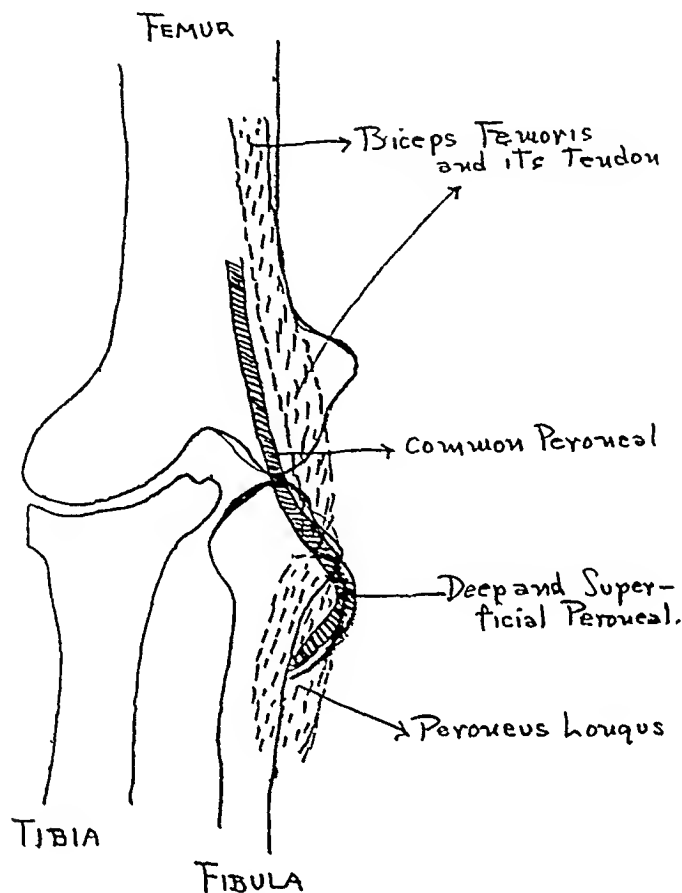
Voluntary exercises and support of the foot were prescribed and the patient recovered function within six weeks after the ankle sprain.

This patient was accustomed to several drinks of whiskey or gin each day. Her habit was not interfered with.

CASE III. H. R., male, aged 49, on August 5, 1939, caught the toe of his left foot on a door-

sill. Before regaining his balance, he sprained his left ankle. The foot was inverted and there had been a rather painful forced plantar flexion

On September 6, 1939, I examined the patient and found a flabbiness of the tibialis anticus muscle, but no atrophy on measure-



POSTERIOR ASPECT

FIG. 1. Course and relations of peroneal nerves.

of the left foot. The patient did not fall to the floor or strike his knee.

The next morning, there was a moderate amount of discomfort but very little swelling and the patient strapped his ankle tightly so that he could play golf. Four hours later he removed the strapping and then first noticed "numbness" of the dorsum of the left foot. By evening, he perceived weakness in extension of the left toes and next there was weakness in extension of the foot. Examination by the family physician disclosed weakness in extension of the foot and toes and eversion of the foot, with no impairment of sensation. The condition was attributed to the tight strapping of the ankle. Massage and electrical stimulation treatments to the weakened muscles were followed by some improvement, which continued spontaneously during the next two or three weeks.

ment, and a slight weakness in extension of the left foot and toes and in eversion of the left foot. There was no impairment of sensation and the ankle jerk was normal. Pressure on the nerve trunk posterior to the lateral border of the neck of the left fibula elicited tenderness. Electrical reactions were not tested.

This patient's physician reported on October 18 that improvement had continued to such a degree that the patient had very little weakness of which he was aware.

The stories of these three patients can be summarized briefly as follows:

1. Each suffered an ankle sprain, the foot being inverted. None of the patients fell to the ground or injured any other part of the body.

2. One patient was naturally loose-jointed, another was drinking during the

evening and may have been relaxed muscularly at the moment the sprain occurred.

3. In two patients, the foot was over-stretched in plantar flexion.

4. Symptoms were noticed immediately in one case, within twelve hours in another, and after a week by the patient who sustained the really severe sprain with considerable pain and swelling.

5. All three patients had clinical evidence of impaired function of the homolateral deep and superficial peroneal nerves.

6. Recovery was complete after six weeks in one case, after six months in another, and can be expected to be complete after three months in the third, most recent case.

7. The use of alcohol by two of the three patients did not apparently alter the course of the disability.

MECHANISM OF THE INJURY

It would seem that in these three patients the ankle sprain directly led to trauma of the deep and superficial peroneal nerves.

If one stands on tiptoe and inverts the foot with the toes turned inward, one can feel tensing of the muscle mass lateral and posterior to the neck of the fibula. If the position of the foot is suddenly forced further, there is a sharp and tense contraction of this muscle mass.

The common peroneal nerve runs medially to the biceps femoris tendon, and terminates superficially in the popliteal fossa overlying the lateral head of the gastrocnemius muscle. Its terminal branches, the deep and superficial peroneal nerves, lie posterior to the neck of the fibula. The deep peroneal nerve passes laterally and distally around the neck of the fibula, pierces the peroneus longus as it runs through this muscle, and then penetrates the extensor digitorum longus and extensor hallucis longus muscles. The superficial peroneal nerve passes beneath the peroneus longus muscle.

In some individuals the ulnar nerve is comparatively loose and easily palpable as it runs through the olecranon fossa. One is

familiar with the fact that overflexion of the forearm or pressure on the olecranon fossa may produce transient formication or paresthesias in the distribution of the ulnar nerve.

The nerve trunk, consisting either of the deep peroneal nerve or of both the deep and superficial peroneal nerves, shows analogous variation. Injuries of various kinds in the region of the lateral aspect of the knee joint and upper end of the fibula may traumatize this trunk. These injuries may be the product not only of a single momentary physical violence but of persistent pressure such as occurs in certain occupations where there is constant kneeling. In Oppenheim's textbook quoted above, page 462, it is stated that forcible sudden supination of the foot may perhaps cause traction and that in such instances the superficial peroneal nerve is usually more affected than the deep branch.

It would seem likely that either anatomic variation predisposing to the effect of stretching, or direct pressure of forcibly contracting overlying muscles, may account for the instances of peroneal paralysis complicating ankle sprain of the type which occurred in these three patients.

CONCLUSIONS

Three cases of peroneal paralysis, apparently caused by ankle sprain, are here described. The mechanics and anatomy bearing upon the condition are discussed. In these cases, it was not feasible to undertake a detailed or stereoscopic x-ray study of the head and neck of the fibula. A sharp lateral border of the neck of the fibula, such a thing as a congenital spur, or other developmental variation would naturally serve as a predisposing factor.

While such a definite paralysis may be a very unusual complication of ankle sprain, it is not unlikely that slight transient involvement may occur more frequently. It would be easy to overlook mild symptoms which would either be disregarded by the patient or masked because of the pain and limitations of motion due to conditions at the ankle joint itself.

TALONAVICULAR DISLOCATIONS*

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THE scattered case reports of astragaloscapoid dislocations show that this condition is relatively infrequent. In 1928, Shands reported 138 cases and added one of his own. Mitchell also reported one case in 1936. In a review of 535 consecutive dislocations of all types from the Willis C. Campbell Clinic, as reported by Hugh Smith in 1937, seven subastragaloid dislocations were found, the incidence being 1.3 per cent.

Shands describes four types: inward, 55.4 per cent of all these dislocations; outward, 33.1 per cent; backward 7.2 per cent; and forward, 4.3 per cent. It can be seen that the majority are of the inward or medial type; the two cases reported in this paper are both of this type. About 34.4 per cent of these dislocations occur between the ages of 20 and 29, the most active period of life, since this is a lesion of severe trauma. For this same reason, the incidence in men is six times as great as in women.

Milch, in 1929, stated that up to that time only thirteen cases of true uncomplicated subastragaloid dislocations had been reported. We are inclined to believe that this is far too conservative an estimate. The reports cited above are probably more accurate. In his report, Milch describes what we believe to be the best explanation of the mechanism of production of these dislocations. He feels that the wedge-like action of the head of the astragalus plays the greatest rôle, basing his deductions on the anatomy and physiology and the astragalus. When the foot is flexed or extended, the astragalus acts as a fixed part of the tarsus; when the foot is supinated or pronated it becomes part of the leg. The talus functions to distribute the body weight to the calcaneus and the

heads of the first and fifth metatarsal bones. It is his opinion that the upward resistance of the ground is transmitted through the tension of the capsular ligaments which oppose the downward force of the body weight transmitted through the head of the astragalus. Other theories advanced by Reisman, Morian and Gumbel partially explain the production of the deformity.

The two cases reported here present contrasting situations. The first demonstrates the ease with which some of these cases can be reduced by closed manipulation and the second shows some of the complications and difficulties encountered in attempting closed reduction.

CASE REPORTS

CASE 1. J. R., a white male, while playing baseball, made a misstep, severely twisting his ankle. He supinated and plantarflexed his foot to the extreme, at which time he felt and heard something snap. The patient was seen about two hours after the injury and at that time the foot was markedly swollen and caused a great deal of pain. The internal malleolus was not palpable, while the external was prominent. A bony mass was present over the dorsum of the foot with the skin stretched taut. The forefoot was held in a position of slight equinus and supination. Roentgenograms (Fig. 1) revealed the head of the astragalus displaced over the cuboid, completely separated from the scaphoid articulation. The other bones of the foot were in normal position and no fracture was visualized. It was thought that the reduction would be difficult, but under gas anesthesia, with one assistant holding the knee slightly flexed to relax the Achilles tendon, the forefoot was supinated and plantarflexed with digital pressure applied over the head of the astragalus. The dislocation was easily reduced and a plaster cast was applied from the toes

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to the groin. The post-reduction x-rays (Fig. 2) revealed the complete restoration of the astragalus. Follow-up after eight weeks and

being displaced upward and medially. No fracture lines were noted. Under deep anesthesia the dislocation was manipulated as in the



FIG. 1. Case 1. Illustration showing dislocation.



FIG. 2. Case 1. Postreduction.



FIG. 3. Case 11. Illustration showing dislocation.

after one year showed complete return of function.

CASE 11. M. S., a 42 year old white male, a bricklayer, fell from a scaffold and injured his right foot. The right foot was displaced medially and inverted. X-ray (Fig. 3) showed a dislocation in the taloscaphoid articulation, the foot

previous case. After twenty to thirty minutes, however, the dislocation could not be displaced from its position over the cuboid. The skin over the head of the talus was so blanched that if left alone for twenty-four hours it would probably have become gangrenous. Therefore, the foot was wrenched and brought over to a

fairly normal position. X-ray through a heavy cast (Fig. 4) revealed that in addition to the dislocation in the astragaloscaphoid joint, the



FIG. 4. Case II. Illustration taken after closed manipulation.

astragalus was displaced from the normal relationship to the ankle joint so that the upper surface faced anteriorly. The cast was split and the edema of the ankle allowed to subside.

Ten days after the injury, an open reduction was done under general anesthesia through a longitudinal incision parallel to and above the flexor hallucis longus, and the astragalus was pried and rotated into its normal position. During the reduction, a small necrotic chip was found at the base of the head of the astragalus. This was removed. The incision was closed and a plaster cast applied from the toes to the mid thigh with the foot in dorsal flexion and eversion. The patient left the hospital eight days later and an uneventful recovery followed, with complete return of function after two months.

The two cases reported are of the medial type which constitutes 55.4 per cent of talonavicular dislocations. When the dis-



FIG. 5. Case II. Illustration taken after open reduction.

location cannot be reduced after a short period of manipulation it is advisable to allow the edema to subside for about ten days followed by open reduction. Too vigorous manipulation may lead to complications as in case two. In the closed reduction a deep anesthetic is of great importance.

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OSSIFICATION OF INFRAPATELLAR BURSAE AND FAT PAD

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OSSIFICATION of the infrapatellar bursae and fat pad per se is infrequently reported in the literature. ing tissue, assume its character, and later become detached, giving rise to a loose body.

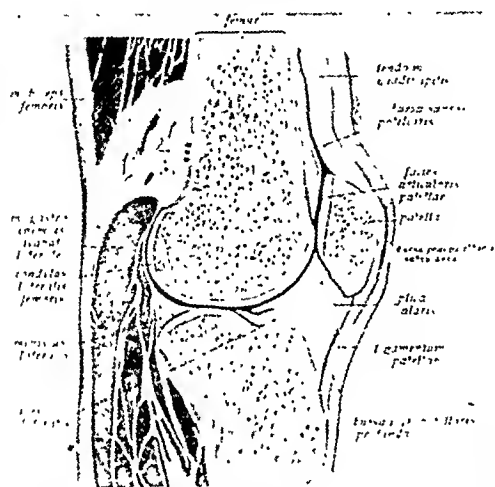


FIG. 1. Sagittal section of the knee joint (Sabotta).



FIG. 2. Preoperative roentgenogram of the knee joint.

Lesions composed of combinations of fibrous, cartilaginous, and osseous tissue, intra-articular in location, are reported. Redi, in 1928, reported a case of ossification of the infrapatellar bursa, which he attributed to a fractured patella received three years previously, and which was confirmed by pathologic study. There have been occasional case reports in which the possibility of this entity was entertained because of radiological studies, but confirmation by operation was lacking.

The first reference to foreign bodies of the knee was made by Ambroise Paré, who in 1558 successfully removed a stone from the knee. Alexander Munro, in 1738, stated that foreign bodies in joints were derived from the articular ends of bone. John Hunter believed that these foreign bodies were the result of changes following the extravasation of blood which tended to organize and adapt itself to the surround-

A. G. Fisher of London classified foreign bodies of the knee joint into three groups: (1) loose bodies composed of unorganized fibrin or necrotic portions of synovial membrane; (2) loose bodies composed of organized connective tissue, other than bone and cartilage; and (3) loose bodies composed of cartilage or bone, or both. All these types may be single or multiple, pedunculated or free, laminated or non-laminated.

Whitelocke of Oxford prefers a simpler classification, based on etiologic factors, and classifies foreign bodies of the knee into: (1) those arising from disease conditions; and (2) those arising from trauma. He is of the opinion that this classification is of great aid in the diagnosis, treatment, and prognosis of the case.

Anatomy. The infrapatellar fat pad is situated posterior and distal to the lower portion of the patella, underlying the proximal portion of the patellar tendon. Posterior-

only, the fat pad partially fills the surfaces between the condyles of the femur and the head of the tibia. The posterior surface of the

related to the fat pad. The superficial bursa is situated inferiorly, just above the tuberosity of the tibia. The deep bursa is



FIG. 3. Knee joint at operation; articular surface of femur; osseous tumor mass indicated by pointer.

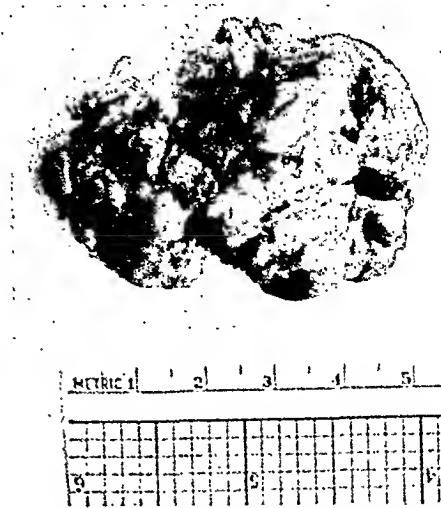


FIG. 4. Osseous mass after removal.



FIG. 5. Microphotograph of tumor showing bone trabeculae.

fat pad is attached to the anterior intercondyloid eminence of the tibia by the ligamentum mucosum. The anterior surface is continuous with synovial fringes of the edges of the patella, known as the ligaments or plicae alares. The infrapatellar fat pad functions as a pressure reducing mechanism to the joint. The cavity of the joint is at its greatest capacity when the knee is flexed to 45 degrees, the fat pad pushing in to prevent a local vacuum. When the knee is extended, the fat pad is pulled forward free from opposing surfaces (Cravener).

The infrapatellar bursae are closely

situated between the posterior surface of the patellar ligament, and the proximal end of the tibia. Both bursae are anterior to the fat pad.

CASE REPORT

E. C. H., 35 year white female, was admitted to the hospital June 6, 1939. Two years before, she had injured her left hand and knee in a fall. Roentgenographic study at that time revealed a fracture of the distal phalanx of the left thumb and osteoarthritic changes in the joints of the hand. It was then noted that crepitus was present in both knee joints, but the knee was not x-rayed. The patient had since complained of pain in the left knee, and

was treated for osteoarthritis. In March, 1939 she fell again, and pain, tenderness, swelling, and immobility of the left knee resulted, persisting to the date of admission to the hospital.

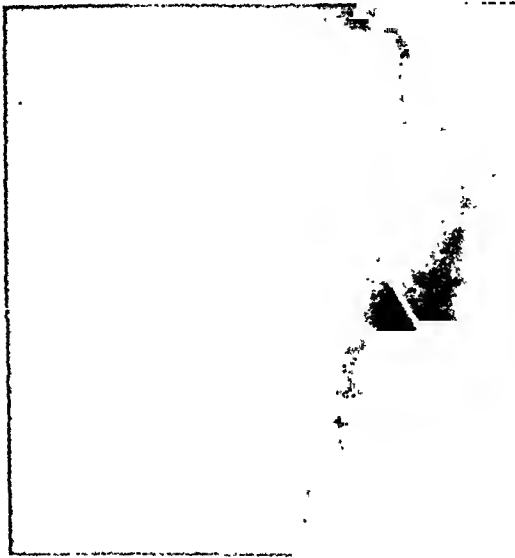


FIG. 6. Postoperative roentgenogram of knee joint.

Examination revealed a swelling of the left knee, reaching a maximum between the patella and the tuberosity of the tibia, with diffuse tenderness and marked restriction of motion. Roentgenographic studies revealed a large calcified mass, apparently in the anterior chamber of the knee joint.

A utility incision was employed and the patella displaced laterally. The joint cavity was opened and explored. The mass was exposed, dissected free, and excised. It measured 5.5 by 4 by 2 cm., and involved the infrapatellar bursae and fat pad. The synovial lining of the joint cavity was normal.

The postoperative course was uneventful. A posterior moulded splint was applied for ten days, following which active and passive motion, supplemented with short wave therapy, was instituted. Motion at the knee joint improved, until 60 degrees of flexion were present and the patient was free of pain.

SUMMARY

A case of ossification of the infrapatellar bursae and fat pad is reported in which good functional result was obtained following surgical excision. The lesion may be looked upon as an osteoma.

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SEPTIC THROMBOPHLEBITIS OF THE SUPERIOR HEMORRHOIDAL VENOUS PLEXUS*

STREPTOCOCCEMIA, CEREBRAL EMBOLUS AND RECOVERY

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THE mechanism by which emboli are deposited into the arterial system from peripheral venous thrombi has always been the subject of medical speculation. Some of the accepted routes are (1) the congenital heart,^{1,2,3} (2) clumps of bacteria passing through wide pulmonary capillaries,⁴ and (3) acute endocarditis secondary to phlebitis.⁵ Cerebral emboli through these pathways have been reported, but as a complication of rectal disease they are extremely rare. The literature contains only one proved and one suspected case.^{6,7} The patient whose case is reported here developed cerebral emboli following a thrombophlebitis of the rectum. An associated streptococemia was treated successfully with sulfanilamide.

CASE REPORT

The patient was a 35 year old white male who had had intermittent rectal bleeding for two years. Three years before the present illness he had had a gonorrheal infection. There were no other significant illnesses and his family history was irrelevant.

Two days before hospital admission he felt pain in the rectum and consulted his physician who supposedly incised "a boil in the rectum." Upon his return home, he began to have sharp, steady lower abdominal pain. The next morning, his temperature rose, he became chilly, and vomited twice. A consultant made a diagnosis of a rectal abscess. Morphine sulfate was given for the relief of abdominal pain, but the patient's condition failed to improve. The temperature rose to 104°F., and he became incoherent, disoriented, and unresponsive.

On examination in the hospital, the patient appeared acutely ill, spoke incoherently, was stuporous, and perspired profusely. Mouth

temperature was 104°F., pulse 130, respirations 26, and blood pressure 100/68. The pupils were contracted, but reacted to light and accommodation. No cranial nerve involvement was found, nor was there any nuchal rigidity. The heart and lungs showed no abnormalities. The abdomen was soft, but markedly tender throughout. There were no palpable masses or muscle rigidity. The bladder was percussed to just below the umbilicus, and on catheterization 28 ounces of clear urine were obtained.

Digital examination of the rectum caused excruciating pain and the sphincter was markedly spastic. There was a small amount of free bleeding. Just above the anorectal line and on the right wall there was a soft swelling extending "finger-like" upward and lost to the reach. Proctoscopy was incomplete because of the patient's irrational state. However, just below the swelling, there was seen a bleeding, ragged, necrotic ulcer about 1 cm. in diameter.

Hemoglobin was 80 per cent; red blood cells 4,300,000 per c.mm.; white blood cells 7,600 per c.mm. with a normal differential count. The Wassermann reaction was negative, the urine normal. Blood sugar was 152 mg. per 100 c.c., and blood urea 12.3 mg. per 100 c.c. The sedimentation rate was 67 mm. per hour (Westergren method). Blood culture showed five colonies of *Streptococcus hemolyticus*.

The patient was given a hypodermoclysis of 1000 c.c. of 5 per cent glucose in saline. His general condition became worse and the next day, the fourth day of his illness, tremors of the right leg and right facial weakness were noted. His face was flushed and there was cyanosis of the lips and finger nails. He again became incoherent and slept restlessly for long intervals. Repeated catheterization was necessary. Medical opinion at the time was that a thrombotic hemorrhoidal vein, palpable at the internal sphincter and extending up the rectal wall, had spread from this local focus into a

* Read before the New York Proctological Society, February 2, 1939.

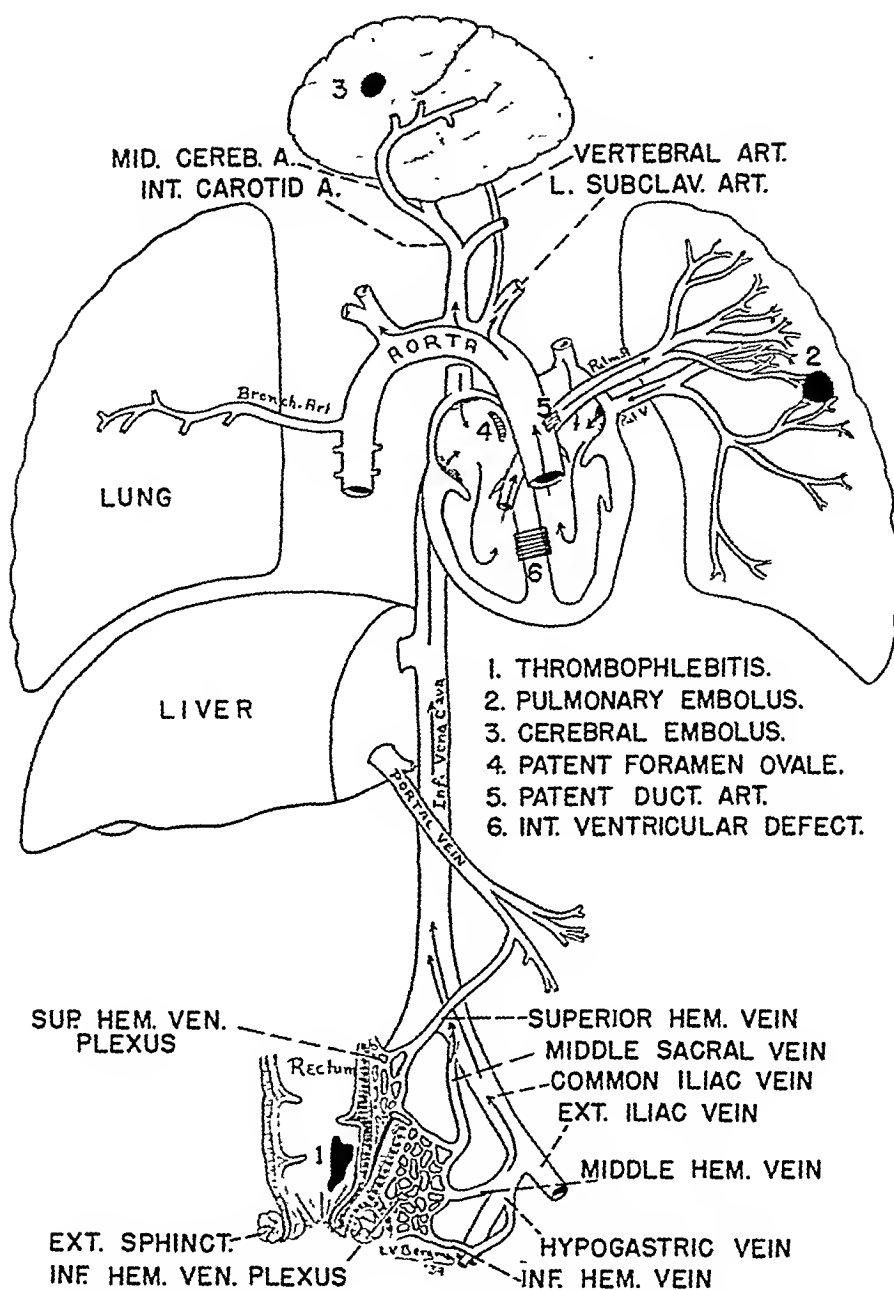


FIG. 1. Schematic drawing illustrating the various pathways of emboli from the veins of the rectum. The arrows indicate the course taken by a rectal embolus (1) through the inferior vena cava into the right heart and pulmonary artery into the lung, (2) eventually absorbed here by the venous capillaries and passed into the pulmonary vein, thence through the left heart into the aorta and then to the brain or (3) other arterial branches. The "paradoxical embolism" is made possible when there is present either (4) patent foramen ovale, (5) patent ductus arteriosus, or (6) interventricular defect.

systemic infection, with possible numerous small emboli lodged in the cerebrum. The high temperature, the profound prostration, the cerebral drowsiness and rapid pulse all indicated a grave prognosis.

Sulfanilamide, gr. 10, every three hours was immediately started. Improvement was noted late the next afternoon. The patient recovered from his drowsiness and was mentally alert. The temperature dropped from 104 to 102F., but toward evening, the patient again became irrational and complained of a severe headache. Rectal examination at this time showed that posterior to and to the left of the thrombosed area previously described, there was a prominent, boggy swelling merging with the former mass. This was considered a rectal abscess. During the night, the abscess apparently perforated and six loose stools were passed. The temperature subsided to 101F. and the rectal mass was considerably reduced in size.

For the next three days steady improvement occurred although the facial paresis, headache, and periods of disorientation persisted. The temperature declined toward normal, and the blood culture at this time was sterile. Accordingly, the dosage of sulfanilamide was reduced from 80 to 40 gr. daily.

On the eleventh day of illness, the patient's condition was definitely better in spite of the persistence of headache and drowsiness. The rectal mass had completely disappeared and there was no pain in the area. On discharge from the hospital on the seventeenth day, he was symptom-free but the right facial weakness and hyperactive reflexes remained.

A neurologic examination, thirteen months later revealed the gait and station steady, the coordination intact, the sense of smell and taste normal and the vision good. There was no nystagmus or diplopia. A definite overactivity of the left side of the face was noted on speaking, while the right side drooped. The tongue deviated to the left. Deep reflexes were present, the right side much more active than the left. An equivocal Babinski was present on the right side.

COMMENT

Thrombosis of the inferior hemorrhoidal vein is seen regularly whereas involvement of the superior hemorrhoidal plexus is comparatively infrequent.⁸ Fortunately,

thrombophlebitis is not often a complication of thrombosis in this region. When it does occur, infected emboli may be disseminated.⁴

Emboli from the hemorrhoidal veins usually terminate in the pulmonary vessels. (Fig. 1.) However, Boyd⁹ states, "It occasionally happens that an embolus arising in a vein lodges in an artery other than the pulmonary artery. Such an embolus must therefore have reached the left side of the heart, although carried by the veins to the right side. This occurrence, known as paradoxical embolism, has always been more or less of a puzzle. The most important example is afforded by puerperal hemiplegia. The usual explanation given is that the embolus has passed through a patent foramen ovale."

Rostan,⁵ in a study of 711 autopsies, found 139 with patent foramen ovale, of which seven cases had paradoxical embolism, three being cerebral. Rabinowitz et al.¹⁰ collected eleven cases of cerebral embolus in congenital heart disease. Nevertheless, it does not seem plausible to explain every case of cerebral embolus on the basis of a congenital heart. Many of these cases may be instances of thrombophlebitis of a cerebral vessel due to clumps of bacteria having passed through the rather wide pulmonary capillaries.⁴ Necropsy in cases of puerperal hemiplegia⁹ has shown a secondary endocarditis on the left side of the heart, the vegetations having formed the source of the cerebral emboli. Finally infarction of the lung may be followed by thrombosis of the pulmonary veins, which in turn may be responsible for embolic phenomena in the cerebral circulation.

Although pulmonary embolism following rectal pathology is not uncommon, serious results are found in comparatively few cases. The double blood supply to the lung coming from the bronchial and pulmonary arteries (Fig. 1) tends to prevent infarct formation. Newman⁷ reported five cases of pulmonary embolism following hemorrhoidectomy, one following the injection of quinine and urea, and one case following

sigmoidoscopy. Cain⁸ and Szancer¹¹ also noted pulmonary embolism as a complication of thrombophlebitis of the hemorrhoidal plexus. However, cerebral embolism following rectal disease is extremely rare. A very careful search of the literature revealed but one substantiated by autopsy reported by Ohm⁶ in 1907. His patient had a thrombophlebitis of the hemorrhoidal plexus which gave rise to repeated cerebral emboli. The patient died and post-mortem examination revealed a patent foramen ovale. Newman's patient developed a hemiplegia immediately after a simple anal fistulectomy.

SUMMARY

1. A case of thrombophlebitis of the superior hemorrhoidal venous plexus followed by a *Streptococcus hemolyticus* septicemia and cerebral emboli is presented.
2. It is our opinion that emboli from the infected thrombus in the rectum lodged in the lungs, filtered through the wide pulmonary capillaries and passed into the arterial circulation of the brain. The absence of apparent endocardial changes and signs of a congenital heart lesion tend to support this view.

3. Rapid and spectacular recovery followed the administration of large doses of sulfanilamide.
4. As far as can be determined this is the first case of its kind on record.

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HEMORRHAGE AND THROMBOSIS OF THE OMENTUM*

THEIR ETIOLOGY IN THE ACUTE ABDOMEN

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HEMORRHAGE and thrombosis of the omentum present diagnostic difficulties. Our experience with this condition produced by trauma in a child prompted us to review the more recent literature, to report our case and to survey briefly six other cases gathered from the records of our hospital in the past twenty-five years.

One of the earliest reports is that of Bush¹ in 1896, who recorded a case of hemorrhage of the omentum discovered at operation. Trauma appears to have played a rôle in the production of an omental hemorrhage cited by Hunter² in 1904, in a woman who complained of right lower quadrant pain following the insertion of a pessary. Hertzler,³ in discussing injuries to the omentum, states that "generally speaking, traumatism to the omentum and mesentery is overshadowed by perforation of the hollow organs and rupture of the solid organs." He collected thirty-four cases recorded in the literature up to 1919 in which the omental hemorrhage had followed blunt abdominal trauma. Eberts⁴ cites a case of spontaneous hemorrhage of the omentum in a 21 year old boy who showed symptoms of perforated acute appendicitis. Sowles⁵ reported a case of traumatic abscess of the omentum in a patient who, six weeks after blunt injury to the abdomen, developed signs of peritonitis thought to have followed duodenal perforation or acute appendicitis. At operation the abscess was found directly over the point of trauma. It is interesting to note that the history of trauma was obtained after the operation. Schomberg⁶ and Hines⁷ both report cases of bleeding into the omentum without stating whether trauma preceded

the condition. Johnson⁸ suggests the clinical entity of thrombosis of the omental arteries because this condition was found at operation in a 63 year old man with cardiac insufficiency who was thought to have acute appendicitis. Labry and Arnulf⁹ record a case of inflammation of the omentum following a blow to the abdomen. Schafer¹⁰ mentions the presence of thrombosis of numerous veins found in the abdominal cavity following trauma. Barsky and Schwartz¹¹ cite a case of torsion of the omentum in a 5 year old child and state, "a blow to the abdomen may initiate the process of torsion directly, or a resulting hematoma within the omentum may cause a sudden alteration in the position of the omentum which may then produce the twisting. Coughing, straining, vomiting, etc., according to some authors, may be responsible for the torsion." A case of hemorrhagic infarction due to venous thrombosis of a large portion of the omentum in a 53 year old man with cardiac failure, is reported by Berger.¹²

CASE REPORT

A 7 year old boy was admitted to the Jewish Hospital of Brooklyn April 9, 1938 with a complaint of abdominal pain which had begun six days previously following a kick to the abdomen by a playmate. At the onset there was no nausea, vomiting, or fever. The first night following injury the child went to bed and the pain disappeared spontaneously. No laxatives or enemata were administered. The next day the child had a normal bowel movement. On April 6 he complained of a sticking pain in the right side of the abdomen and was given an enema, again with the disappearance of the pain on the following day. Two days later severe abdominal pain, without nausea

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or vomiting, developed and the boy was unable to sleep. He ate well, but following an enema had a persistence of the pain in the right side

free under McBurney's point, appeared grossly normal. To the right of the midline, corresponding to the area where swelling was

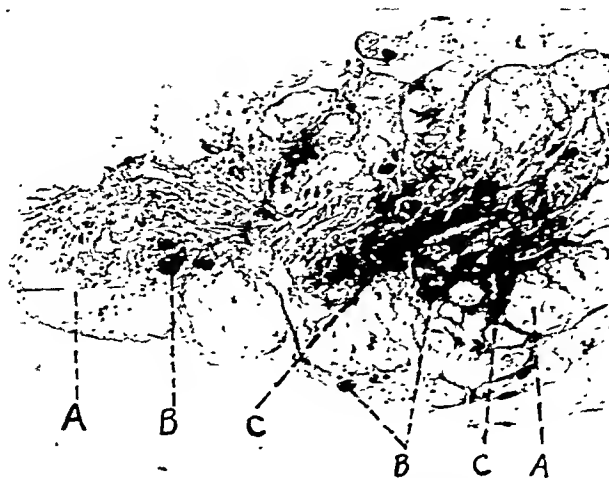


FIG. 1. A, omental fat. B, engorged distended vessels. C, hemorrhage into the omentum.

of the abdomen. There was no fever. On the morning of admission the pain was very severe and he was unable to walk.

Physical examination revealed a well developed boy who did not appear acutely ill. The temperature was 99.0°F., pulse 84 per minute, and respiration 24 per minute. The abdomen was not distended, but there was marked spasticity and rigidity along the entire right rectus muscle especially in the upper half. There was exquisite tenderness and also rebound tenderness in the right upper quadrant and to a lesser extent in the left upper quadrant. A definite, irregular, vertically elongated mass could be palpated in the right side of the abdomen slightly above the level of the umbilicus. Rectal examination was essentially normal. Urinalysis was normal. A blood count showed a leucocytosis of 13,000 with 85 per cent polymorphonuclear leucocytes and 15 per cent lymphocytes. One of us (L. E. S.), who saw the child in surgical consultation, thought he had an acute suppurative appendicitis with a local peritonitis, and that the mass was formed by the omentum covering the inflamed appendix.

The peritoneal cavity was opened through a right midrectus muscle-splitting incision. We deviated from our usual McBurney incision because the history of an injury to the abdomen caused a doubt in our minds as to the diagnosis of appendicitis. The appendix, lying

palpated preoperatively, was a mass which, when delivered into the wound, appeared as a large portion of markedly indurated, purplish-blue omentum. The vessels on the surface of the mass were engorged. It was attached to the lateral surface of the cecum and ascending colon. After liberation from the colon, the hemorrhagic omentum was found also attached to an appendix epiploica, similarly discolored, somewhat thick and edematous, and adherent by fine filmy adhesions to the adjacent cecum. The cecum and ascending colon were red and edematous and were partly covered by fine adhesions. The bowel was normal in thickness, configuration, and caliber, and no masses were palpated within the lumen. The infarcted omentum and appendix epiploica were excised and an appendectomy performed.

The vermiform appendix was grossly and microscopically normal. The omentum contained scattered hemorrhages and the vessels were markedly distended with blood. (Fig. 1.) The appendix epiploica presented a similar picture of extensive hemorrhage and engorgement of the vessels.

The child made an uneventful recovery and was discharged on the eighth postoperative day. A follow-up after he left the hospital found him in perfect health.

In six other cases gathered from our hospital records, there were four males and

two females, their ages ranging from 22 to 61 years. The onset in all cases resembled that of an acute inflammatory condition within the abdomen. Diagnoses were either acute appendicitis or acute cholecystitis. In none was a tumor palpated before operation, but all recovered following excision of a hemorrhagic or thrombosed portion of the omentum.

SUMMARY

1. A case of hemorrhage into the omentum is reported, and six other similar cases briefly summarized, all simulating an acute abdominal condition.

2. The importance of blunt trauma to the abdomen is stressed as an etiologic factor in this condition.

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New Instruments

A NEW CERVICAL TENACULUM

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IN the performance of hysterosalpingography the ordinary cervical tenaculum leaves much to be desired. In twelve and one-half inches. The handle makes a slight obtuse angle with the shaft of the instrument so that traction tends to

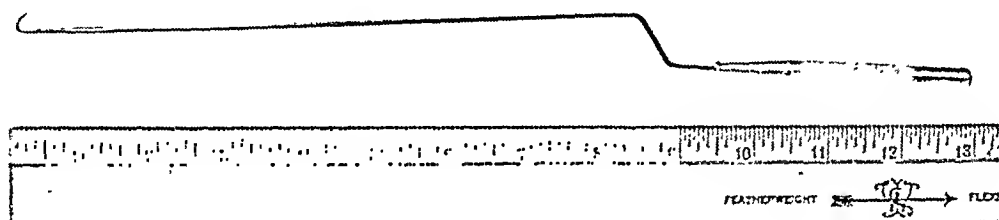


FIG. 1. Illustration of tenaculum.

the first place, there is a certain amount of pain when the tenaculum is applied. Often on positioning the patient and injecting the contrast media, it will tear out and usually at the most inopportune time. In the badly lacerated cervix, which requires tenacula on both anterior and posterior lips to prevent escape of the solution, the handles tend to block the field of vision.

After experimenting with various patterns, the author has designed an instrument which is more simple in action and more secure. It has proved so satisfactory, not only in my hands but in those of other gynecologists, that the following description is submitted:

As may be seen in the illustration, it consists of a fine, straight, tapered point set at an acute angle on a long applicator with an offset handle. The point is five-eighths of an inch in length and set at an angle of forty-five degrees. The distance from the bend of the point to the bend of the offset is eight and one-half inches. The offset is approximately three quarters of an inch. The entire length from handle to tip is

fix the point in the cervix and at the same time bring the handle out of the direct line of vision.

When in use, the point is inserted in the cervix midway between the external os and the fornix. The application may be anterior, posterior or lateral as desired. If the point is kept sharp, there is no pain on introduction and a slight jerk on the handle fixes the point well in the musculature of the cervix. Movement of the patient and tension on the instrument simply serve to fix it more firmly in the cervix. The offset handle is well out of the way and an additional instrument may be used on the opposite lip if needed. Removal is easily accomplished by simply reversing the manouver used on insertion.

In examination and treatment the instrument is valuable in exposing and steadying various areas of the cervix. In addition, it has proved to be useful in certain surgical procedures about the cervix. The tenaculum described is simple and inexpensive, and it is believed that it will be useful in other hands.

S P E C I A L M O N O G R A P H

Surgical Aids to the
Intracavitary Treatment
and Study of Cancer
of the Stomach

BY

EDWARD M. LIVINGSTON, M.D.

AND

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AMERICAN JOURNAL OF SURGERY, Inc.

NEW YORK • MCMXLI

First Colored Photograph of a Gastric Cancer To Be Taken through a Gastroscope.

SURGICAL AIDS TO THE INTRACAVITARY TREATMENT AND STUDY OF CANCER OF THE STOMACH*

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NEW YORK, NEW YORK

FOREWORD

IN order to give every patient with a cancer of the stomach the maximum chance for survival and to bring to those with advanced disease the greatest attainable degree of relief during the fragment of life that remains, a multiplicity of surgical technics for gastric resection, gastric exclusion, internal gastrointestinal anastomosis and external fistula formation, must be utilized. To these operative measures a variety of medical, radiological and electrosurgical procedures are added, as indicated. No stereotyped plan of treatment or single mode of therapy proves adequate in the management of any consecutive series of unselected patients observed, since gastric carcinomas vary within wide limits as to their extent, location, microscopic grade, clinical stage, complications and metastatic spread. Cancer of the stomach is one of the most protean forms of malignant neoplastic disease. Aside from the one clear cut and well recognized indication to find and remove, wherever possible, every resectable tumor of this site, there is need for a strict individualization of cases and for a thorough case selection with reference to the many therapeutic optional courses from among which the clinician must choose.

More must be accomplished for patients with gastric cancers that are unresectable. Under present conditions of diagnosis an overwhelming majority of those who apply for treatment in any clinic now fall within this category.¹ It is not sufficient, important as this may be, to confine attention only to a search through the total number who harbor the disease for that relatively small minority among whom excisional surgery may prove curative, adopting for the far greater proportion an attitude which approaches one of frank de-

* From the Gastric Service of the Memorial Hospital for the Treatment of Cancer and Allied Disease.

spair and therapeutic nihilism. The needs of the inoperable or unresectable patient are often desperate. Even limited palliation, it should be recalled, if secured for relatively large numbers, might readily equal or exceed in total life benefits the gains now obtained through certain of the more spectacular operations such as total gastrectomy or cardiectomy, associated with so high an immediate operative risk and applicable to so small a percentage of patients.

In a search on the Gastric Service of The Memorial Hospital for additional methods by which to improve the status of those with nonresectable cancers, considerable attention has been focused on the subject of endogastric or intracavitary therapy. It is the purpose of this monograph to describe a number of specific advances in equipment and technic for research and treatment by this intraventricular route. In their aggregate these measures when more widely employed should go far toward advancing palliative, if not curative, attainments in the management of malignant tumors of the stomach. And they will serve to enhance present knowledge concerning the gastric mucosa adjacent to carcinomatous growths and of the gross and microscopic responses which result from intensive gastric irradiation.

Operative surgery for stomach cancers is divisible into four types:

1. *Exploratory Surgery* (Peritoneoscopy; laparotomy)
2. *Excisional Surgery* (Total gastrectomy, cardiectomy, partial gastrectomy, segmental resection)
3. *Palliative Surgery* (Gastroenterostomy, gastrostomy, pyloric exclusion, jejunostomy)
4. *Radiation Surgery and Electrosurgery* (Combined treatment)

The first three of these headings have been extensively dealt with in surgical literature. Yet the allied forms of treatment encompassed in heading four have received but scant emphasis. Despite the impressive accomplishments already secured in the management of nonresectable tumors of other internal organs by intralumenary and intramural applications of radium, with or without allied electrocoagulation, singularly little can be found concerning attempted applications of such measures in the care of stomach cancers. If analogy alone offers any reasonable basis on which to anticipate possible benefits inherent in an extension of such methods to gastric carcinoma, this field of allied therapy appears to have remained distinctly underdeveloped. That urgent need exists for

additional intracavitary investigation and research is strikingly disclosed by the very paucity of specialized equipment now available for endogastric work.

This monograph on "Surgical Aids to Intracavitary Treatment and Study" deals with pioneering activities in this field of combined therapy and endogastric instrumentation. New methods of approach to the gastric lumen, new forms of gastric irradiation and new types of intraluminary equipment are depicted. No attempt has been made at completeness of presentation of the several subtopics considered, nor at ultimate polish of subject matter. Not all of the instruments or technics described have as yet been subjected to prolonged clinical applications. Portions of the monograph are largely pictorial. The primary object is that of stimulating increased general interest in the subject and of encouraging in other hands the improvement, modification and further adaptation of the methods and instruments described. This aim of increasing the effective means of treatment for patients with stomach cancers that are unresectable is so worthy a goal that the slightest success in this direction would constitute a sufficient *raison d'être* for a communication of this length and character.

Outline

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Part I

SURGICAL AIDS TO ENDOGASTRIC
INSTRUMENTATION

1. INTRODUCTION

A. DEFINITIONS

Intracavitary treatment for cancer of the stomach signifies therapy applied to the interior of the organ and in immediate contact with the primary ventricular tumor. Endogastric instruments include all equipment specifically designed for use within the gastric lumen and in direct relation to the gastric mucosa. The appliances to fall within this category are extremely varied. Such armamentaria encompass not only instruments for observing and photographing intraluminary conditions and removing biopsy specimens, but also others for delivering air, fluids, electrical currents, roentgen-rays and radium or radon to the interior of the viscus. In the descriptions of operative and instrumental technic which follow, these terms intragastric, intracavitary, intraluminary, intraventricular, endogastric, and transmucosal, are used interchangeably, but the selected adjectives intracavitary and endogastric will be stressed.

B. RELATION OF SURGERY TO INTRACAVITARY THERAPY

Except for oral instruments, as the flexible gastroscope, which are passed into the stomach by way of the mouth and esophagus, all endogastric studies and therapy are dependent on surgery for their clinical application. Treatment must be given either during the course of an exploratory operation following intraperitoneal exposure of the gastric mucosa, or administered postoperatively by way of a surgically created gastrostomy goose-neck tract. Hence surgical therapy and intracavitary therapy are as a rule directly allied, they are at times synonymous, and are always interrelated. Endogastric instrumentation, furthermore, in itself constitutes a form of surgical procedure. Impressive end results already secured in other regions of the body where nonresectable malignant tumors have been treated by direct applications of irradiation and electrosurgery have stimulated the surgeon to extend his interest beyond the sphere of radical operations alone and created a wider viewpoint toward the whole problem of management of gastric cancers of every stage and type.

Two introductory headings of somewhat general nature further serve to define the full relationship between operative surgery and endogastric methods. Basic points brought to light in these few

preliminary paragraphs are of no small moment in the judicious clinical use of the intragastric instruments and technics to be described.

C. THE GENERAL IMPORTANCE OF GASTRIC CANCER THERAPY

It has well been stated that "the numerical importance of gastric cancers places their study among the most significant that could be made in the cancer field in the present stage of our knowledge of the subject."² And it has been pointed out that "there are more deaths from cancers of the stomach than from all malignant tumors of the lip, tongue, cheek, tonsil, pharynx, larynx, salivary glands, thyroid, male and female breast, ovary, uterine cervix and corpus uteri combined." Cancer of the stomach constitutes a numerical fourth or fifth of the entire cancer problem. Is it not imperative, then, with from 40,000 to 50,000 new cases of stomach cancer annually in the United States Registration Area alone, to continue to explore and to re-explore to their full limits any forms of non-excisional therapy which hold the slightest degree of promise?

Something of the comparative meaning of this total loss of life from gastric carcinomas is disclosed by noting the relative number of deaths yearly from malignant tumors of this single organ in relation to those which have resulted from traffic accidents and from war. The number of Americans who died of war wounds or were killed in action during the six major wars in which the United States has engaged since its birth in 1776, and which encompassed fifteen years of combat, totalled 244,357. The aggregate number of deaths resulting from the past fifteen years of traffic accidents totalled 441,912. But the number who died in this country of stomach cancers during the last fifteen-year period was in excess of half a million (approximately 600,000).³ Every available force should be brought to bear in combating a cause of death of such magnitude. And the slogan "worse than war" suggested for cancer as a whole, applies with equal force to cancers of this single viscus. The definitive cures obtained in the treatment of gastric carcinoma inevitably play a dominant rôle in influencing the total end results for all cancer therapy; and there can be no answer to the cancer problem unless this includes a solution to the problems of gastric cancer as well.

D. YARD-STICKS FOR A MEASUREMENT OF END RESULTS

Sixty years of unimpeded surgical treatment of cancers of the stomach has served to establish the efficacy of excisional therapy

within relatively fixed limits. Both in America and abroad reported ten year survival rates have reached as high as 20 per cent among individuals with malignant neoplasms of the stomach discharged from hospitals after partial gastrectomy.^{4,5} Five year definitive cures have been recorded, furthermore, of as high as 60 to 63 per cent for gastric carcinomas still confined to the stomach and unassociated with local or distant lymphnode invasion at the time of resection. (Fig. 1.) The accomplishments of extirpational surgery for patients with *resectable* stomach tumors have become impressive and can no longer be questioned. Larger numbers of surgical clinics are reproducing favorable end results once confined to but few pioneering centers where special attention had been focused on gastric surgery. And the further extension of surgical benefits to reach widening numbers with resectable tumors appears likely to constitute the most certain advance for immediately ensuing years. The advent of cardiectomy and proof that tumors of the cardiac end of the stomach as well as those of the corpus and pyloric antrum may, in certain instances, be successfully excised constitutes another step in the progress of excisional surgical care. Surgical literature, with good evidence, displays an increasing note of optimism.

Yet it by no means follows that these impressive attainments for *resectable* gastric carcinomas represent the net end results from surgical management of the disease as a whole. Counterfactuals, as disheartening as the foregoing are favorable, require equal notice. For example, throughout the history of abdominal surgery no clinic has ever been able to report as many as five living patients at the end of five years among any one hundred unselected patients who apply for treatment. This means that, despite all favorable surgical reports, if every patient with a cancer of the stomach were to be admitted promptly at time of diagnosis to the most highly specialized surgical clinics, still over 90 per cent would inevitably die of their disease within ten months, while over 95 per cent would succumb before the shortest time for a measurement of definitive cures. The crux of the matter lies in the fact that three-quarters to four-fifths of all patients harboring the disease have tumors which under present conditions prove unresectable when the cancer is first discovered. Thus from 70 to 80 per cent of cases are completely outside of the realm of curative surgery and for these patients there is no faintest hope of successful extirpation of the tumor.

Four factors combine to hold surgical end results inexorably to fixed low levels of cure. These factors constitute the so-called

"surgical cure formula" for the disease. A study of these factors, as shown in Figure 2 reveals why no marked improvement in net

High Percentage of Cures Among Patients with Resectable Cancer

"Cure Formula" for Resectable Cases

Cures =

$$\left(\frac{\text{T.R.}}{\text{Total Resectable}} \right) - \left(\frac{\text{R.M.}}{\text{Resection Mortality}} \right) - \left(\frac{\text{N.D.}}{\text{Natural Decline Rate}} \right)$$

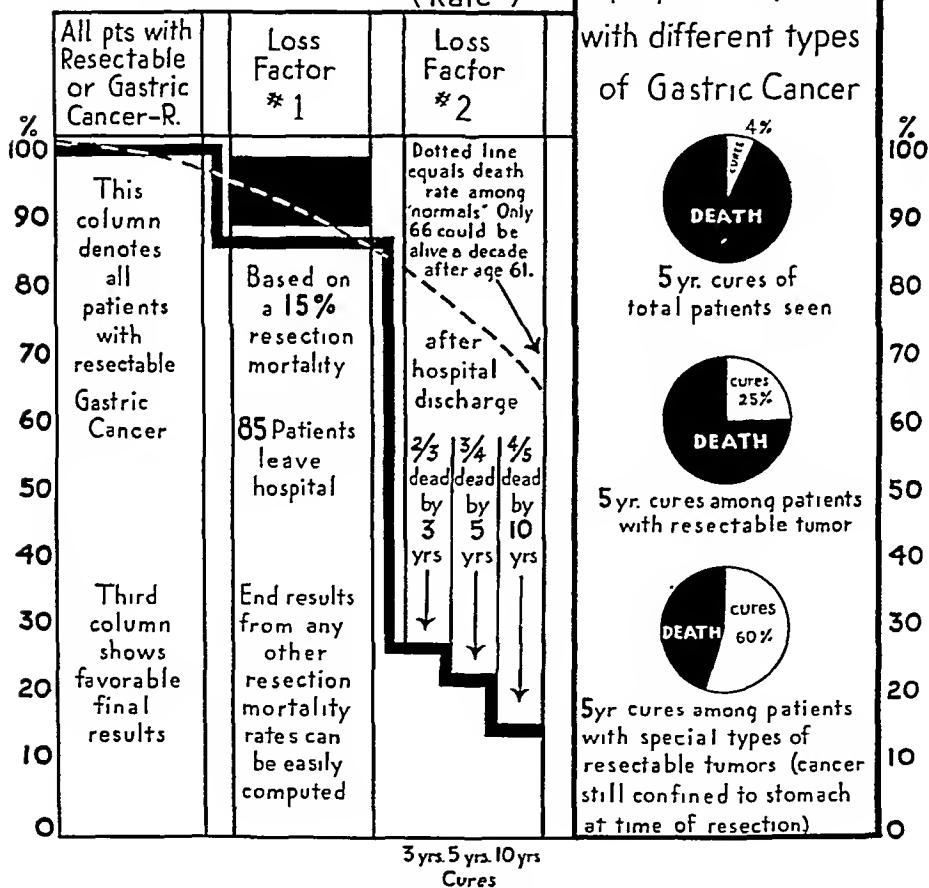


FIG. 1. The "surgical cure formula" for resectable cancers of the stomach.

end results can be looked for in the near future, even though improvements occur in every individual item of the formula. These unfavorable factors are (1) high rates of total inoperability, (2) high

Low Percentage of Cures Among Total Patients Observed

"Cure Formula" for Total Patients Seen

Cures =

$$\begin{array}{c} \text{T.S. minus I.O. minus U.R. minus R.M. minus N.D.} \\ \left(\begin{array}{c} \text{Total} \\ \text{Patients} \\ \text{Seen} \end{array} \right) - \left(\begin{array}{c} \text{Inoperable} \end{array} \right) - \left(\begin{array}{c} \text{Unresectable} \end{array} \right) - \left(\begin{array}{c} \text{Resection} \\ \text{Mortality} \end{array} \right) - \left(\begin{array}{c} \text{Natural} \\ \text{Decline} \\ \text{Rate} \end{array} \right) \end{array}$$

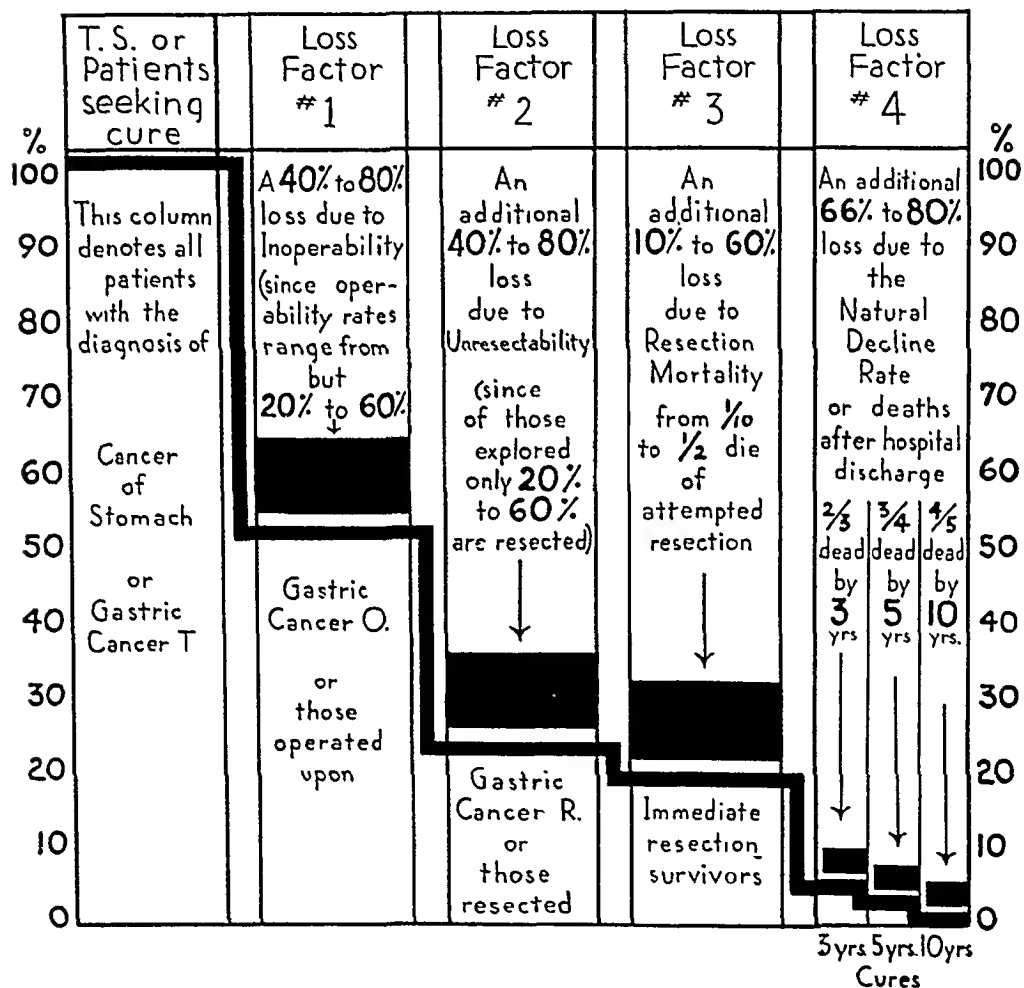


FIG. 2. The "surgical cure formula" for unselected cancers of the stomach. Over 75 per cent of all cancers of the stomach are outside the realm of curative surgery; and for this overwhelming majority of patients there is no hope of successful resection of the tumor. It is for this group of patients, some of whom have very early cancers which are unfavorably situated for excision, that additional means of therapy are sought.

rates of unresectability even among those fit for surgical exploration, (3) high rates of resection mortality whenever more than selected prepyloric cancers are operated upon, and (4) high rates of

VALUE OF PALLIATIVE OPERATIONS FOR CARCINOMA OF THE STOMACH

Life Duration after Palliative Operations (Exclusive of resections)

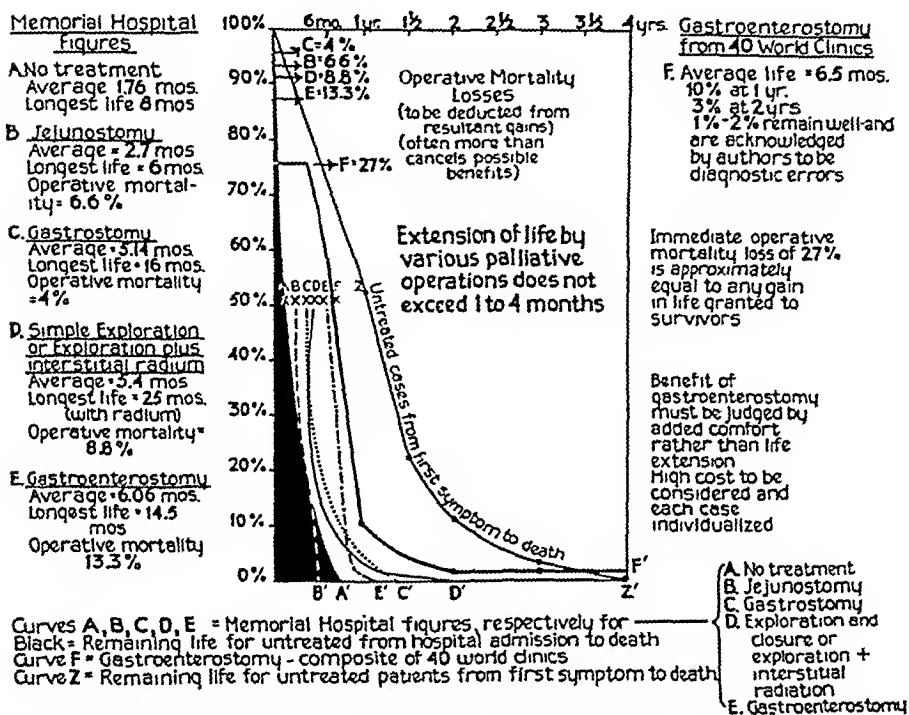


FIG. 3. Graphic study of the end results from all types of palliative therapy exclusive of palliative gastrectomy.

prompt local recurrence after successful gastrectomies. No amount of surgical enthusiasm for the performance of gastrectomies wherever feasible can mask the fact that from the onset of professional care the overwhelming majority of cases are beyond the scope of extirpational surgery. And as matters now stand *the acme of sixty years of surgical effort is a maximum survival rate of but two to four individuals living at the end of five years from among any one hundred unselected patients applying for treatment.*

End results secured from palliative surgery of all types are graphically depicted in Figure 3. No operation except resection has proved able to extend life for more than an average of four months beyond life expectancy where no treatment is given. The

curves plotted deal with reports on the following procedures: gastroenterostomy, gastrostomy, surgical exploration with interstitial irradiation, gastric exclusion and jejunostomy. For many of the operations the immediate operative mortality rate serves to cancel the gains in added months of life accorded to those who survive the surgical measures studied. Palliative surgery for stomach cancer (except for palliative gastrectomy) must be viewed in terms of symptomatic relief and added comfort rather than on the basis of any marked extension of remaining life. In selecting the operative measure to employ and in judging between the risks to be taken and the resultant gains reasonably to be anticipated, the surgeon is aided by measurement yard-sticks of this character; and these must also play a rôle in any estimations of the effectiveness of intracavitary treatment.

E. THE DURATION OF LIFE FOR UNTREATED GASTRIC CANCER

The remaining fragment of life for the average patient with a cancer of the stomach from the time of diagnosis until death is less than three and one-half months, unless treatment is employed. Numerous studies have been made of the course of gastric cancer when untreated. Those of Lord Moynihan, of Pack at the Memorial Hospital, of Nathanson at the Huntington Memorial Hospital and of Livingston and Lieber at the New York City Cancer Institute are shown in an accompanying chart. These data are of considerable importance since estimations of the value of any forms of therapy must be based on a comparison of the results which follow treatment, with the known length of survival for untreated patients. The average term of life both from onset of symptoms until death and from time of established diagnosis until death are recorded. The number of months to elapse between onset of symptoms and time of diagnosis (average of eight months) represents a tragically long period of delay since it equals two-thirds of the entire period between the first manifestation of the disease and its fatal termination when treatment is not given. There is every reason to anticipate that a shortening of this delay period could materially improve the end results of therapy and effectively raise the percentage of resectable stomach cancers encountered. These figures also reveal that it takes but a relatively short time to measure the value of any form of treatment for malignant tumors of this particular organ, so rapid is the fatal termination when the disease runs an untreated course.

And whereas a number of years would be required safely to estimate the comparative efficiency of therapy for cancers which run a relatively slow course (skin cancers, breast cancers) from eighteen

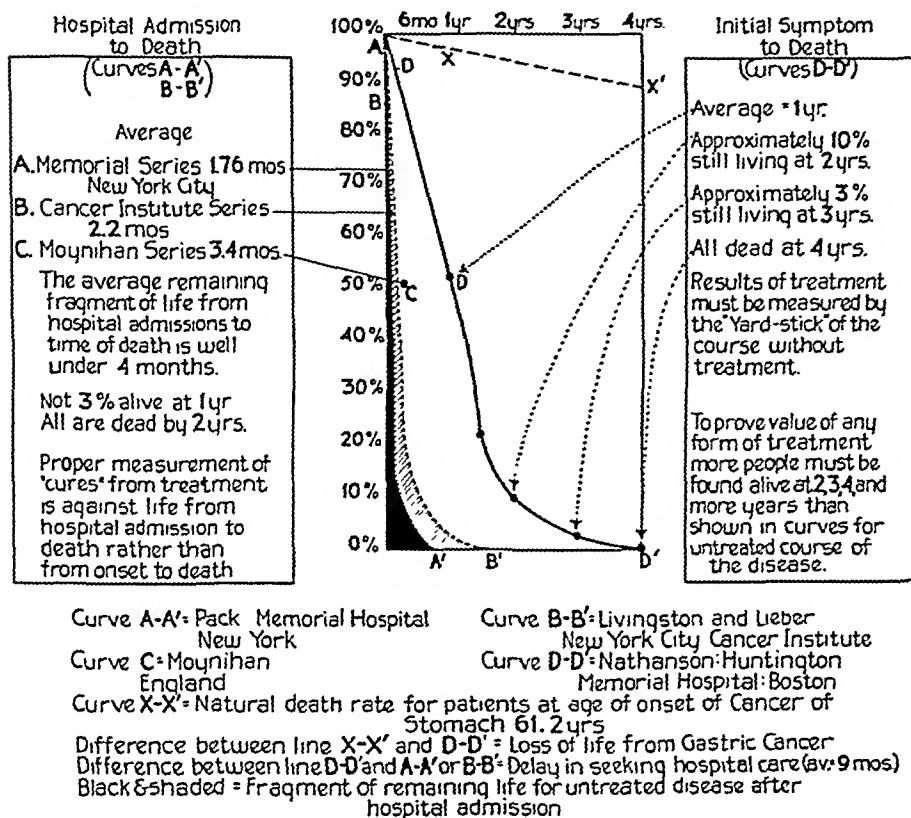


FIG. 4. Duration of life for patients with untreated cancers of the stomach: a "natural yard-stick" for measurements of the effectiveness of treatment.

months to two years is a sufficiently long period during which to gain a reliable index as to what is being accomplished by endogastric or other types of treatment for gastric carcinomas. Yard-sticks of measurement of the type shown in these figures are absolute requisites in the clinical use of radiosurgical and endogastric therapy and in the evaluation of optional methods. (Fig. 4.)

F. PROSPECTS FOR RADIOSURGICAL AND ENDOGASTRIC TREATMENT

Who could remain satisfied in the treatment of a form of cancer which represents so large a proportion of *all* malignant tumors, with but one to four per cent of patients living at five years from curative therapy, and but an average of four months life extension

for the best forms of palliation? Do not such end results insistently demand an open minded study of all new avenues of promise? Factors which hold these end results at such low levels have been clearly identified; more than half a century of surgical treatment alone leaves no likelihood of *striking* gains along similar lines in the immediate future; and a distinct moral responsibility appears to exist for more active studies of additional therapeutic methods. Radiation therapy, in particular, has been inadequately investigated, especially as to its intracavitary applications. It is certain that many carcinomas of the urinary bladder, uterus, and recto-sigmoid have been completely destroyed by purely local measures. There is considerable evidence, as summarized in Part II of this monograph that the present lack of development of endogastric irradiation is more surely to be accounted for on the grounds of a limitation as to routes of approach and a failure to evolve a suitable armamentarium than on the basis of any biological differences between carcinomas of the stomach and those of other internal organs.

Radiation therapy has accomplished so much in life saving, in the treatment of cancer in general and has proved so invaluable an ally to surgery for tumors of still other sites, and has so definitely outstripped surgery in the management of certain specific forms of malignant neoplastic disease, that nothing but unequivocal proof of regional unsuitability could serve to justify the sporadic and cursory clinical applications of gastric irradiation which have been made to the present. Who could affirm, after reviewing the brief history of intragastric irradiation and studying the limited use thus far made of radiosurgical methods for this particular organ, that all reasonable possibility had been exhausted of securing additional gains from treatment applied directly to unresectable gastric tumors?

The techniques and equipment for endogastric instrumentation and intraventricular irradiation described in pages which follow offer added incentive for further clinical studies in this field. Such physical appliances as an anterior gastroscope, multiple-lumened radium applicators, endogastric balloons, electrosurgical biopsy tools, contact x-ray anodes, air-valves for a control of larger gastrostomy fistulas, cameras for photographing in color the gastric mucous membrane and other instruments depicted now furnish the necessary means for conducting vigorous clinical tests in this

domain. Under stimulus of the scant requirements needed to display definite palliative and curative advancement, and under the guidance of analogous technics employed with success in the treatment of other internal carcinomas, there is ample reason to anticipate renewed interest and an accelerated pace in the more widespread investigation of potentialities inherent in intracavitary therapy.

2. THE ANTERIOR GASTROSCOPE OR OPERATING TELEVENTROSCOPE

A basic consideration for endogastric therapy is that of gaining easy access to the interior of the stomach. Direct visualization of the full expanse of the ventricular mucous membrane is desirable. Highly specialized instruments must be developed for endogastric work, just as has been necessary for intracavitary treatment within other body viscera.

It is not difficult, with a well constructed gastrostomy, to render the lumen of the stomach as accessible for observation and instrumentation as are the rectosigmoid, bladder or larynx. Thus to convert one of the most hidden, dreaded and *internal* cancers into an *externally approachable cancer* is an accomplishment of considerable practical moment. Extreme differences as to curability between most external as contrasted to internal cancers is to a considerable degree simply an expression of the immeasurable advantage inherent in this single factor of tumor accessibility.

Anterior gastroscopy as a routine procedure for the systematic use of all gastrostomy stomas for a repeated study of intraventricular pathology has long awaited the assembly and unification of a suitable armamentarium. From the time of Beaumont and Pavlov sporadic attempts have been made to utilize gastric fistulous tracts for clinical investigation if not for tumor therapy. Preliminary efforts of the latter type have only served sharply to accentuate the necessity for adequate equipment and to attest to the value of the anterior approach.

Makeshift instruments as borrowed from the cystoscopist and laryngologist, or infant tools of reduced calibre suitable for passage through fine gastrostomy stomas have given promise of things to come rather than to have fulfilled demands for a standardized technic. The greater has become professional consciousness of this ultimate need the more insistent has been the pressure for an assembly, improvement and special modification of available instruments. Increased efforts have of late been made to evolve a truly serviceable anterior gastroscopic outfit. There seems little question but that now anterior gastroscopy will ascend to its rightful position of well deserved recognition in the treatment of gastric neoplasms and become a recognized instrument for mucosal studies.

Foremost among the advantages which the anterior gastroscope holds over the flexible oral instruments is the fact that the anterior endoscope represents a tool for operative maneuvers as well as one

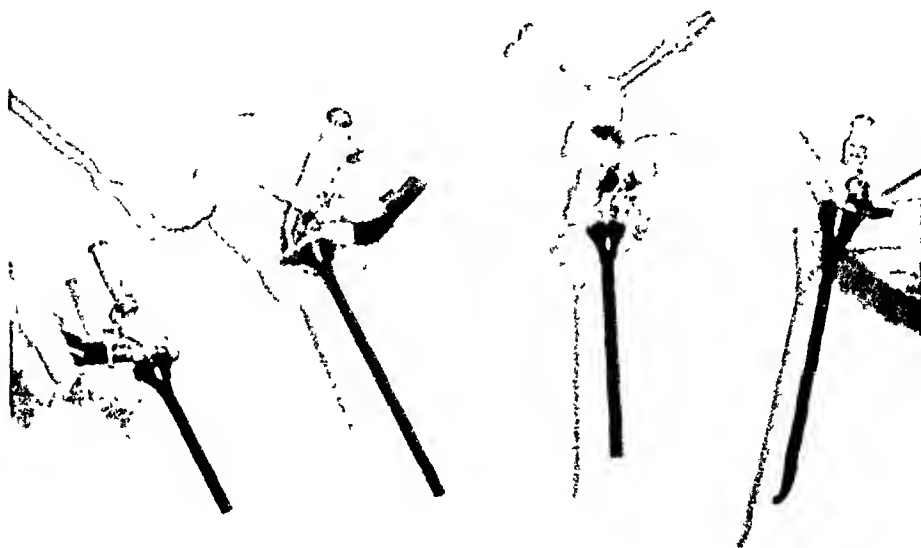


FIG. 5. The operating televentroscope. A form of anterior gastroscope provided with a telescopic and focusing lens system combined with open endoscopic tubes for intra-gastric instrumentation. From left to right: (1) The monoplane vision telescope; (2) the periscopic vision telescope; (3) the double vision or teaching telescope; (4) the intragastric resectoscope with monoplane telescopic vision.

for observation alone. No less than twelve additional advantages will be cited following a description of equipment.

DESCRIPTION OF THE TELEVENTROSCOPE

This outfit (Fig. 5) consists of an electrically lighted endoscope supplied with a telescopic lens system. The name, derived from tele (distance) plus scope (to look), plus venter (the stomach), means literally, to look into the stomach from a distance; and this use of a focusing telescopic system of lenses distinguishes the anterior from the oral instrument. A range of vision is here provided that is not possible with any lens system of fixed focus. The lens system is achromatic, producing a magnification of five times up to a range of 25 cm. A swivel joint allows the adjustable ocular to be swung aside at will, permitting the insertion of a variety of adjuvant instruments into the open tubes.

The Tubes. These are strong, glare-proof, noncorrosive, non-metallic endoscopes of special composition, manufactured under the trade name "surgimold." Their black color and light-absorbing



FIG. 6. Intracavitary study, using the monoplane telescope. Direct inspection of the interior of the stomach after insertion of the anterior gastroscope through a Janeway gastrotomy.

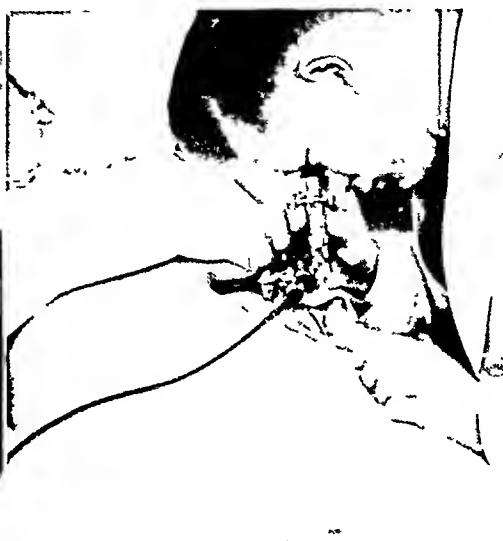


FIG. 7. Intracavitary study, using a periscopic telescope. This right-angle periscopic ocular facilitates inspection of the upper third of the stomach.

surface protects the eye of the operator from undesirable highlights, permitting visualization of every detail within the gastric lumen in its natural color. The tubes are virtually indestructable and never require refinishing. They pass with minimal friction and thus do not excite the muscular contractions sometimes caused by metal instruments, particularly when cold. Sterilization is effected by boiling. The tubes are straight and of various lengths from 10 to 24 cm. (4 to 9 inches), and are supplied in diameters from 25 F. to 38 F.

Lighting. An adjustable lamp which recedes within the handle of the instrument when not in use produces a diffuse white light of suitable brilliance, free of fluctuations, shadows or reflections. The searchlight beam penetrates deeply within the gastric lumen, regardless of the length or calibre of the endoscopic tube employed. Lamp, cords and instrument handle are all boilable without deterioration. An "on-and-off" button on the handle controls the lamp, ensuring economy and long life. The position of this retractable

light outside of the viscus means that the illumination is never affected by blood, mucous or gastric juice—a common difficulty with instruments lighted at their tip.

Current. This is optionally supplied by dry-cells, by any standard electrosurgical unit, or by a house current of either alternating or direct current, on voltages of 130 to 200, or of 200 to 250 volts, using a special rheostat to control the intensity of illumination. Non-kink boilable cords connect the instrument head with the source of electrical energy.

The Telescopes. Single, double or triple telescopes are available. The double adjustable telescopes are of “Y” construction and allow two observers to inspect the same field. One of the authors (E. M. L.) has devised the two types of periscopic telescope illustrated, and these teaching instruments have been provided with unusually high degrees of magnification for a study of mucosal patterns. With the periscopic ocular the observer may stand erect over the patient while the endoscopic tube is manipulated at right angles to his line of vision—a considerable advantage for diagnostic work and for keeping the observer at a distance from the moist fistulous tract. The televentroscope is especially adapted to the diagnosis of minor alterations of the mucous membrane and brings to view lesions readily overlooked by the naked eye or in hurried inspections through an oral instrument. (Figs. 6 and 7.)

Biopsies. Straight grasping forceps, punch biopsy tools, and electrosurgical snares or endoscopic resectoscopes are all suitable for use through the open endoscopic tubes.

Electrical Resectoscopes. Electrosurgical tools especially designed for use with this Cameron instrument are later discussed, as are the resectoscopes for application with the Wappler unit.

Color Endogastric Photography. This subject has also been assigned a special heading.

Inflation. The universal head of this instrument is provided with an air-tight pneumatic chamber and pressure bulb for ballooning the stomach walls whenever desired.

Suction. Suction is provided by inserting small calibre suction tubes through the endoscopic lumens; or special endoscopic tubes of compound construction may be had which provide continuous suction at the tip of the instrument by way of a second or suction passage.

TECHNIC OF ANTERIOR GASTROSCOPY

In making a general examination the selected endoscopic tube is heated to body temperature, lubricated and gently introduced

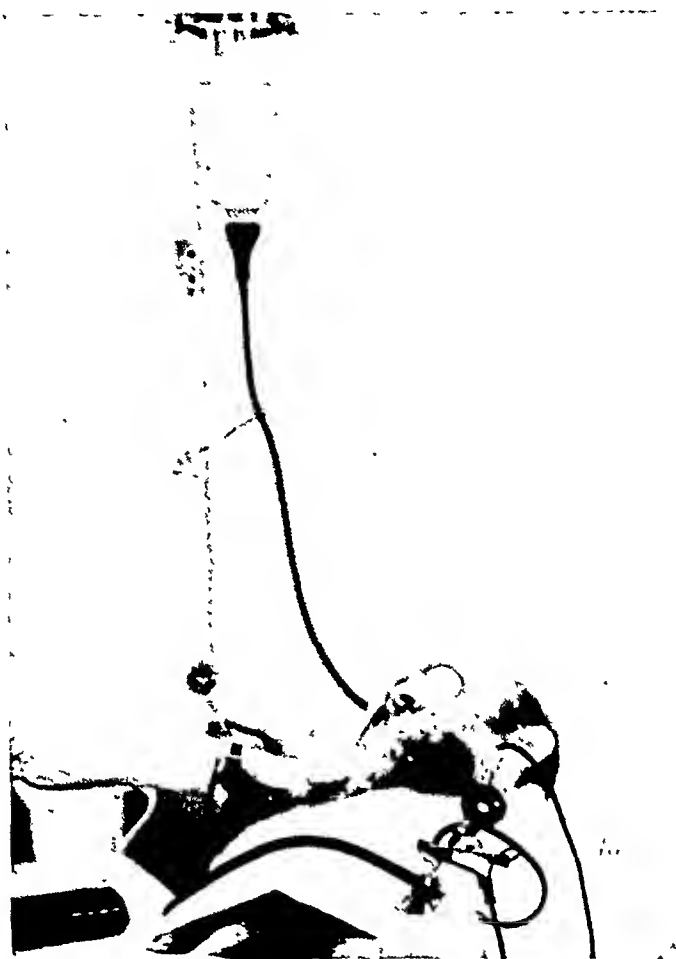


FIG. 8. Cleansing and irrigation of the interior of the stomach through an anterior gastroscope provided with a two-lumened tube. Clear fluid may also be used for inflating the organ prior to visualization of the stomach walls.

into the gastrostomy tract. Preliminary dilation with Hegar cervical dilators may be employed, or the gastrostomy tract enlarged by lateral skin incisions under novocaine if necessary. The latter should be performed as a rule the day before prolonged studies are contemplated to ensure a dry field; otherwise applications of adrenalin, pressure and suction will be required for an interval. The patient is in the supine position on the table, the operator

seated at his side, using a high stool. After instrumentation the obturator is withdrawn, the universal head applied and the light elevated from its recessed position. Gastric suction, air inflation or water distention are now applied, as indicated. A special deodorant and cleansing buffer solution may be used for irrigation or physiological saline solution with adrenalin may be employed. After use the entire instrument, including handle and lamp may be sterilized by boiling and the unit is easily disassembled and reassembled. (Fig. 8.)

Endogastric inspection should be systematic. Search is made for polyps, ulcers, foreign bodies and neoplasms; but also for sclerosis, edema, atrophy or other evidences of gastritis. The cardia, fundus, pylorus and pyloric antrum are identified. Respiratory movements, sphincteric actions, the amount and character of the gastric contents (secretions) and other points are noted in orderly fashion. Experience and training here, as elsewhere, will enhance diagnostic abilities. Biopsies and photographic records are always desirable. The instrument has double value, combining diagnosis and therapeutic instrumentation as elsewhere described.

ADVANTAGES OF ANTERIOR GASTROSCOPY

While the major advantage of televentroscopy and anterior instruments over the flexible oral instrument has already been cited, a number of additional advantages will be briefly enumerated. (It is to be understood, however, that the fields of these gastroscopes are so distinctly separate that there is no conflict between them.)

1. Gastrosopic studies may be prolonged and made at any selected intervals with the anterior instrument. The clinician enjoys the willing consent of the patient for repeated studies since discomfort is minimal or absent.

2. Biopsy specimens may be secured (single biopsies, multiple biopsies, serial biopsies) through the anterior instrument which cannot as yet be accomplished by the flexible oral instrument with its closed lens system. Thus studies of pathologic changes and responses to irradiation need no longer await surgical re-exploration or autopsy.

3. Color photography has been achieved by use of the anterior televentroscope, giving permanent records of intraluminary changes.

4. The "blind spots" and inaccessible zones of the flexible oral gastroscope are readily visualized by the anterior instrument. This is

of particular importance in studies of the region of the pyloric antrum.

5. The anterior gastroscope is so easy to pass that its use requires no special training. Thus it is an excellent teaching instrument and proves a serviceable tool in the hands of any physician.

6. The operating televentroscope costs but a small fraction of the price of the oral instrument.

7. Electrosurgical tools may be employed by this anterior route, and this may now raise intracavitary electrosurgery to a new level of efficiency.

8. Interstitial implantations of radium or radon may be made when desired by use of the anterior route, and these new instrumental adaptations illustrated allow greater accuracy of technic than formerly possible in the use of less specialized equipment.

9. Endogastric balloons and multiple lumened tubes may be adjusted to favorable positions for intraluminary irradiation by use of the anterior inspection devices.

10. The anterior gastroscope may in favorable cases be passed as far as the ampulla of Vater and to the midesophagus, making the instrument at once a gastroscope, a duodenoscope and a retrograde esophagoscope.

11. Larger gastrostomy stomas with nonleak air-valves for their control may soon make it possible, under direction of the anterior endoscope, to direct low voltage or "contact" x-ray anodes against intragastric tumors, as is done in the urinary bladder by suprapubic openings. This would, however, necessitate smaller anodes than are yet available.

12. Not only may physical agents such as radium and electricity reach the stomach by this anterior route, but medications as well, may be applied to the gastric mucosa by way of two lumened tubes traversing the televentroscopic lumen. Thermal reactions can thus be secured, and this accessibility of the gastric mucous membrane renders the method ideal for studying newly developed biological and biochemical agents under investigation as to their causal relation to gastric cancer. The anterior gastroscopist is in a favored position for aiding etiological studies. This assistance to gastric experimental studies may ultimately prove to be one of the most lasting values of such endoscopic equipment.

ANTERIOR GASTROSCOPES WITH CLOSED LENS SYSTEMS

In addition to this instrument just described as assembled for the Memorial Hospital by the Cameron Surgical Specialty Company,

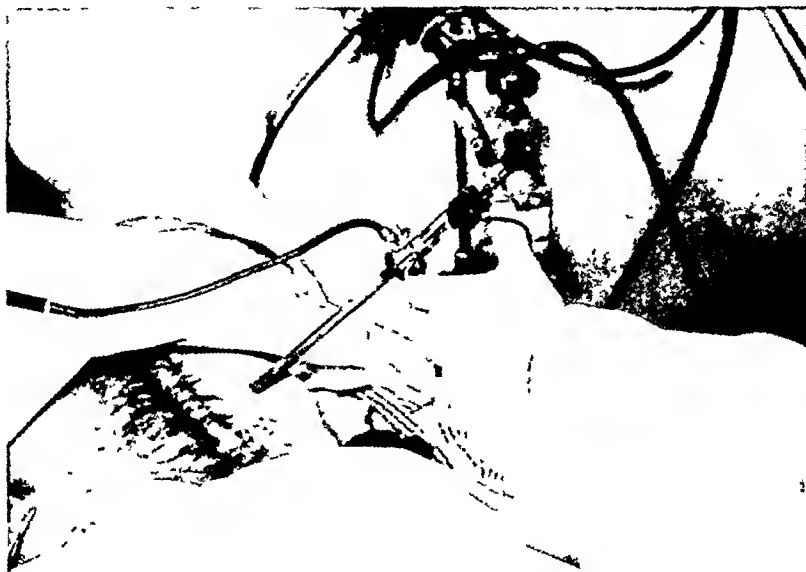


FIG. 9. An anterior gastroscope having a closed lens system. The Nesbit modification of the Stern-McCarthy cystoscope is here employed as an observational instrument.

another anterior gastroscope is being assembled for this Gastric Service through the kindness of Mr. Frederick Wappler of the American Cystoscope Company. (Fig. 9.) The features of this latter outfit will not be described in detail since they are essentially those of the Nesbit modification of the Stern-McCarthy cystoscope and prostatic punch equipment. The special features thus far worked out for gastrosopic work are described in the trade literature and will be elsewhere published. Each of these units has its advantages and disadvantages. Both are suitable for endogastric photography and electrosurgery as well as for other types of instrumentation, and both represent striking advances in the field of gastric research and treatment.

3. COLOR PHOTOGRAPHY FOR STUDIES OF THE GASTRIC MUCOSA

The frontispiece of this communication reproduces the first color photograph of a gastric carcinoma to be taken through a gastroscope. So far as we are aware, it is, in fact, the initial color photograph taken of the interior of the stomach in the living patient by any method other than photography at the time of operation. The advantage in having for permanent record good visual reproductions of the precise intragastric conditions, in natural color, requires little emphasis. Numerous observers thus become able to obtain views for study at leisure that could formerly be had only at the ocular of the observational instrument. Morphological, physiological and gross pathological changes can be studied by this method and serial pictures taken at selected intervals offer comparative records of marked clinical value. Postoperative and postirradiation changes within the stomach, oncological variations and the mucosal pattern adjacent to malignant tumors can be followed in detail by endogastric color photographs. Final ability to secure good color pictures of the gastric mucosa marks the termination of a long period of diligent effort to attain this highly desirable goal.

Schindler, in his monograph on gastroscopy, summarized the history of gastrophotography from 1898 until the time of publication of his book in 1937.⁶ This authority discusses at length the many inherent obstacles to endogastric photography and recounts the long attempts to overcome them. He concluded at that time that gastroscopists generally considered efforts at gastrophotography as a clinical means of diagnosis, to be already obsolete. He did not discount the possibility of advances for some rather distant future in this field but stated in no uncertain terms his verdict concerning the then existing equipment. The so-called "gastrophor," for example, he found to be "unreliable and of no use at all."

Four chief difficulties concerning its use were cited: First, that there was no way of being certain as to exactly what portion of the mucosa was being exposed to the sensitive intragastric films, deep within the lumen of the organ. Second, that the tiny pictures obtained were usually blurred. Third, that the shadows and highlights prevented a truly representative reproduction of internal conditions. And fourth, that it was impossible to introduce a

sufficiently intense light within the viscus to give desired results. Schindler was himself an outstanding investigator of gastric photography, since some years earlier he had secured and published a

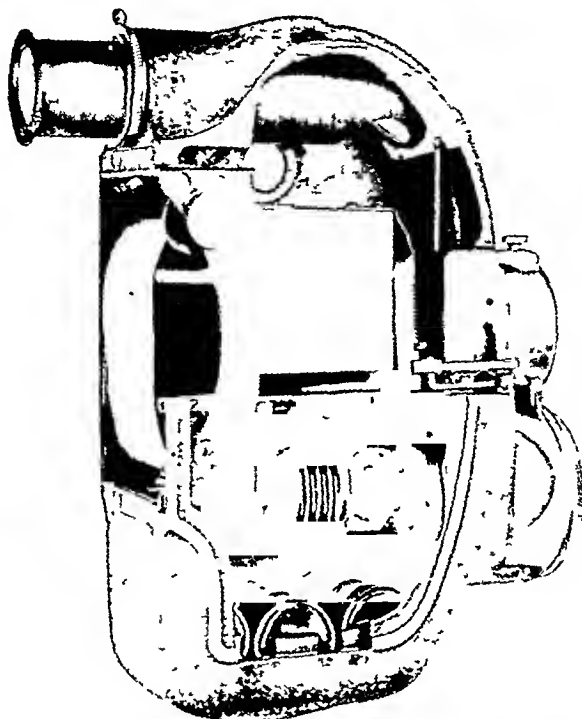


FIG. 10. A clinical camera for intragastric color photography. The figure shows details of construction of this camera

considerable series of pictures of the type then procurable through his rigid oral instrument. He stated that certain of these black-and-white miniatures gave "a rather good idea of the topography of the gastric mucosa"; nevertheless after exhaustive efforts in this work he concluded, "We shall need a considerable length of time to develop useful color photography of the stomach."

Recent advances in clinical photography have been so rapid that this predicted interval has become greatly foreshortened, leaving gastric in vivo color photography already an actuality. This end was attained within a relatively few months after success in similar work within the urinary bladder. Pictures of the interior of this organ were first published by Ballenger, McDonald and Coleman, of Atlanta, in March, 1940.⁷ The photographic studies of these investigators represented true pioneering, leaving it a

matter of but little difficulty to reproduce their end results with reference to picturing the gastric mucosa. As can readily be seen, the stomach which has a short gastrostomy goose-neck tract is

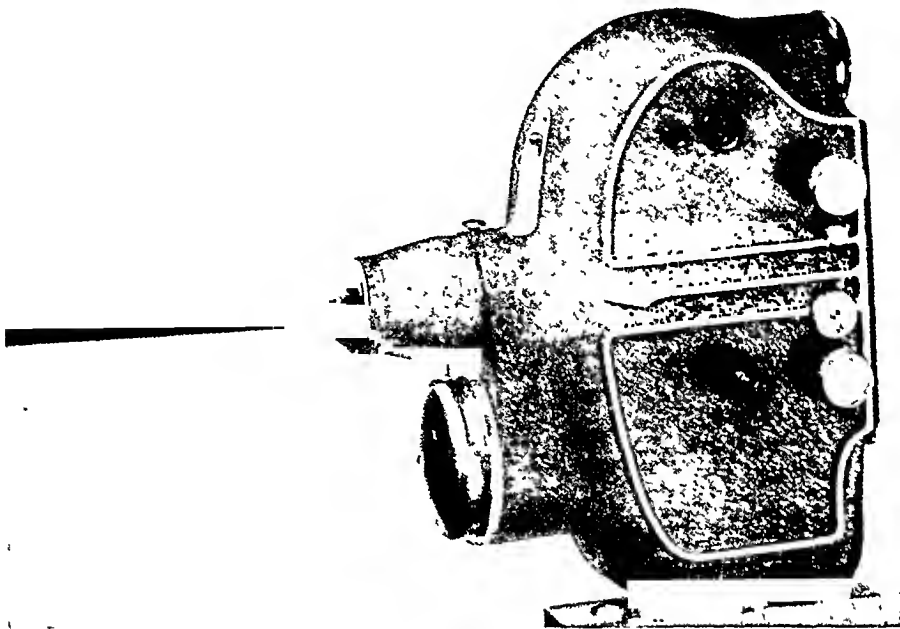


FIG. 11. The Cameron color-flash clinical camera provided with conical adaptor for intragastric tubes.

physically similar in every way to the urinary bladder with its urethral communication with the body surface. Recognition of this fact has left it only a matter of persistence and adaption of equipment to obtain the initial picture shown in the frontispiece. While much improved color photographs are already being secured on the Gastric Service of The Memorial Hospital, this particular view was chosen for reproduction because of its historic value. A Cameron Color-Flash Camera was employed for these endogastric studies; and the accurate reproductions of local pathological conditions made possible by this camera for pharynx, rectosigmoid and vagina are amply attested to in the current pages of numerous medical journals.

This Cameron camera (Fig. 10) first became commercially available in May, 1939, and scores of units are now in use throughout the country. A technical description of the instrument will here be brief since details are supplied by the manufacturer. It takes only a glance at the pictures secured by this instrument to show the nature of the advance made over use of artists' reproductions of their concepts of intragastric conditions. The cost of color

photographs is now so low as to encourage wide use of this method for the maintenance of clinical records.

Clinical Use of the Camera. Operation of this instrument is simple and requires no previous training in photography. A series of Wabash No. 0 or Mazda No. 7 photoflash bulbs are secured and a roll of No. 135 A Kodachrome film. Purchase of the latter includes the cost of development. A bulb is placed in the flash bulb chamber and the film loaded, which are the only requirements for clinical use, since all other steps are made automatic by directions attached to the camera itself. Focal points are fixed through the use of multiple lenses. A series of prisms and mirrors direct the light into the gastroscopic tube and the operator sees the view obtained by a view-finder and pilot light. Camera shutter and flash bulb are synchronized by an electrical device and one bulb is used for each picture secured. Results are accurate and the process is simple and economical. Each printed color film (already suitable for screen projection) costs less than twenty cents. Thus in practical application the steps are few: Pass the endoscope, secure the desired view, attach the camera to the ventroscopic head, check the field by means of the view finder, press the camera release and the picture has been filmed. The accompanying pictures of this Cameron camera reveal all details of instrument construction and the method of attachment of camera to endoscopic tubes. (Fig. 11.)

4. "GIANT GASTRIC FISTULAS" FOR INTRACAVITARY INSTRUMENTATION

The foundation of modern gastric physiology was laid by William Beaumont through his laborious studies of the human stomach by way of a "giant gastric fistula." His only equipment was "a gum-elastic tube, a magnifying glass, a scale, a thermometer, and incubator consisting of either a water-basin on a sand-bath or an armpit, a muslin filter, nutgall, and his five senses."⁸ Thus equipped and fully cognizant of the importance of a rare opportunity for medical research which suddenly confronted him, Beaumont with indefatigable zeal earned for himself the title of "The Patron Saint of American Physiology." This large gastric fistula resulted from the accidental discharge, at close range, of a musket directly into the upper abdomen of the half-breed Canadian Indian, Alexis St. Martin. A sharp fragment of rib, thus dislodged, pierced all coats of the stomach, leaving a permanent mucous-lined communication between gastric lumen and skin. In this classic example is found not only proof of the potentialities inherent in an anterior approach for gastric investigations, but also evidence of the compatibility of large gastrostomy wounds with extended life. For, while St. Martin was but nineteen years of age at the time of the accident, yet "that old fistulous Alexis" still bore the opening, of undiminished calibre, sixty-four years thereafter. Solicitous relatives, upon his death at eighty-three, convinced that enough had been ascertained from this particular organ, deposited Alexis a full eight feet under the sod, in order to confound all those who had expressed the wish to conduct additional and postmortem investigations on that already much overworked viscus. The reports of Beaumont on this famous case, which include his "fifty-one inferences," are among the most treasured documents in medical archives. Yet, "The man was greater than his work" (Osler); and selected statements that have been culled from his writings⁹ might well be taken by present-day students of intragastric function and disease as an inspirational creed:

"I had opportunities for the examination of the interior of the stomach—." "I availed myself of the opportunities afforded—." "I am fully aware of the importance of the subject—: I am therefore willing to risk the censure or neglect of critics, if I may be permitted

to be the means, directly or indirectly, of subserving the cause of truth." "I consider myself to be a simple student of truth,—a humble investigator." "My opinions may be doubted, denied, or approved—: but their worth will be best determined on the foundation on which they rest,—the incontrovertible facts." "Truth, like beauty, 'when unadorned is adorned the most' and, in prosecuting these experiments and inquiries, I believe I have been guided by its light."

The term "giant gastric fistulas" is selected to signify all gastrostomies deliberately fashioned with increased calibre to facilitate the intragastric passage of diagnostic and therapeutic instruments. In general, the ease of endocavitary instrumentation is directly proportionate to the diameter of the passage through which these tools must pass in reaching the gastric lumen. When the only function of a gastrostomy is that of introducing liquid nutriment into the upper alimentary canal to prevent a distressing death from starvation or dehydration due to obstruction within terminal esophagus, little is necessary other than a tract of sufficient size to accommodate a No. 10 to No. 14 French catheter. Additional requirements are a stoma that will not leak, one that cannot close prematurely, and an operation easy to perform, of short duration, and associated with low operative risk. But when repeated inspection of the gastric mucous membrane and intracavitary therapy are planned, obvious advantages accrued in having the gastrostomy tract and external stoma of considerably increased diameter.

Operative techniques for creating such enlarged tracts are essentially the same as those already currently employed, save for the amount of gastric wall utilized to fashion the goose-neck tube. The recent advent of air-valves that can control leakage from gastrostomy stomas makes it possible to devise fistulas of large calibre without danger of unwanted cutaneous irritation of the anterior abdominal wall. By means of these air-valves the opening into the stomach can be securely closed or widely opened at will, in a manner already discussed, thereby combining the advantages of both small and large stomas.

The types of gastrostomy most frequently employed on the Gastric Service of The Memorial Hospital are (1) the Depage-Janeway technic, and (2) the Beck-Jianu technic. The former method is widely used so that the briefest verbal description of the

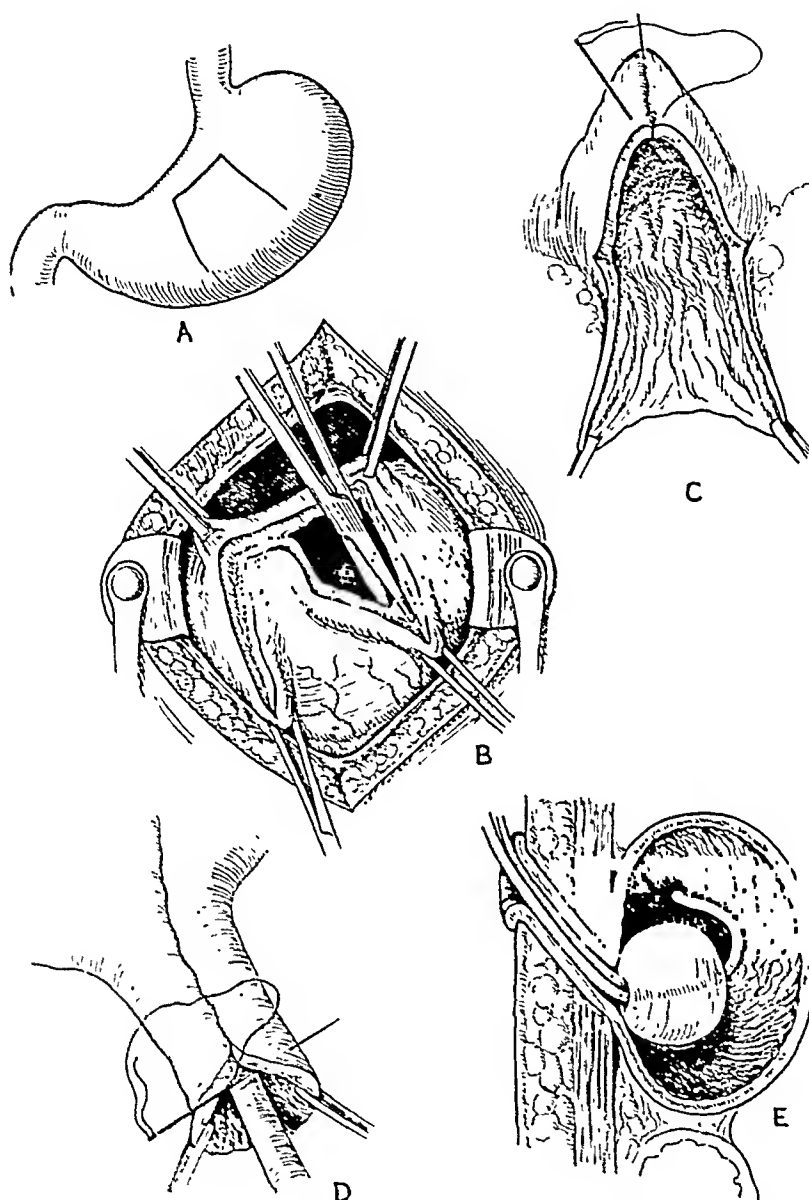


FIG. 12. The Janeway gastrostomy being fashioned with an enlarged stoma for intracavitary instrumentation and therapy. A, outline of trap door flap on anterior surface of the stomach. B, incision of the gastric wall to develop the flap. All layers are included. C, beginning approximation of the cut edges of the stomach to close the defect. The Connell suture is continued outward along the flap to construct the mucosal lined tube. D, the goose-neck of the gastrostomy is nearing completion. The feeding catheter is in place. E, the nonleak air-valve is in place. This intracavitary balloon may be deflated and removed at will, leaving the tract empty for endogastric studies.

technical steps will be given. The artist's drawing is sufficient to illustrate the procedure for creating a "giant mucous fistula" by this method. It is of little importance whether the base of the flap is located along the lesser curvature (Depage method) or the greater curvature (Janeway method); the point for present emphasis concerns the ultimate diameter of the resultant goose-neck tract. The dimensions of the flap illustrated are 7 cm. at the base of the flap and 5 cm. at its free margin. The perpendicular length of the gastrostomy passage will naturally vary with the size of the individual stomach and the location of the flap with reference to the pylorus. All mucous fistulas should be made at a distance from malignant tumors, when present, in order to avoid an early invasion of the stomach from extensions of the cancer.

Operative Technic. The steps of the operation are as follows (Fig. 12): A short incision (3 to 6 cm.) is made just beneath the costal margin or xiphoid, entering the peritoneal cavity. This incision may be median or paramedian; perpendicular, or oblique. The stomach is grasped with a Babcock clamp and drawn into the wound. The free peritoneal cavity and wound margins are protected by moist laparotomy pads. The proposed window of gastric wall is now delineated by four clamps placed with reference to the dimensions just stated. The three lines of incision are severed by a sharp scalpel, passing through serosa and muscularis only. Submucosal vessels are doubly clamped, severed and ligated. A stab wound is made through the mucosa and the gastric contents aspirated. The mucous membrane is then cut by scissors along these three lines of incision, laying open the tongue-like flap of anterior gastric wall. A No. 20 French tube is passed into the stomach and through the pylorus, its free end fastened temporarily by a clamp at the free tip of the everted gastric flap. The initial suture line is of fine chromic catgut. This approximates the mucosa of the gastric wound and is continued to fashion the gastrostomy goose-neck tube. The second and final suture line is of linen or silk. A Connell or running Lembert suture is employed, with inversion of the gastric wall and goose-neck canal, giving broad serous approximation. The gastrostomy stoma is delivered through the upper extremity of the abdominal wound, closing the remainder of the incision by through-and-through nonabsorbable sutures or in tiers. Ample room must be left for the gastrostomy canal to provide against encroachment on its lumen and ischemic necrosis of the tract. The mucosa of the tip

of the tube is finally sutured to the adjacent skin by fine silk sutures. It is only when postoperative endogastric therapy or mucosal studies are contemplated that gastrostomies of this increased calibre are made.

A MODIFIED BECK-JIANU GASTROSTOMY

The identifying features of this technic include a gastrostomy of large calibre, a relatively long tract and one that is created from the greater curvature of the stomach with its blood supply furnished by the left gastro-epiploic artery.

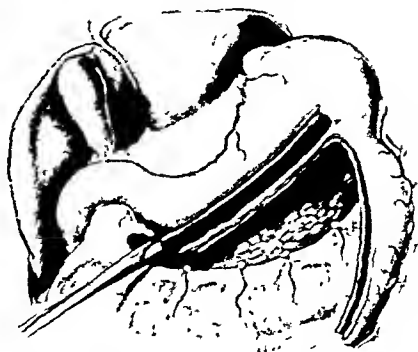
Historical Note. This procedure was described by Amza Jianu, a Rumanian surgeon, in 1912. His primary object was the fashioning of an artificial prethoracic esophagus from stomach wall.¹⁰ The American surgeon, Carl Beck, in 1915, published the description of an almost identical technic. The latter paper contains the following statements:¹¹ "In 1904 and 1905 when Alexis Carrel was associated with me in Chicago, we made some experiments forming a union of the esophagus to the stomach for the purpose of studying an operative procedure for the cure of obstructions of the esophagus—. About 8 years later Jianu of Bucharest (after Wullstien and others had done some work in this line) brought out an identical method and published it in Germany. . . . Our experiments were published in the Illinois Medical Journal during 1905, but unfortunately did not find their way into the broad stream of literature, so that it remained for a European experimenter to revive them—, and the method became known as the Jianu operation." There is no evidence that either Beck or Jianu performed the operation on the living human prior to their publications. Ropke was the first to use the method in clinical practice; and papers soon appeared from Willy Meyer (1913),¹² Horsley, and others, attesting to the feasibility and safety of gastrostomies made in this manner.

Operative Technique. The modified Beck-Jianu operation in use on The Gastric Service of The Memorial Hospital has previously been described in detail by Pack¹³ and this description is here reprinted. (Fig. 13.)

The operation utilizes the greater gastric curvature to form a long pedicled tubular flap with its base at the fundus. If the gastrostomy is intended for feeding purposes only, a high, left mid-rectus incision is done; if the surgeon plans to do an esophagectomy and wishes to utilize the tubed flap in reconstruction of the esophagus,



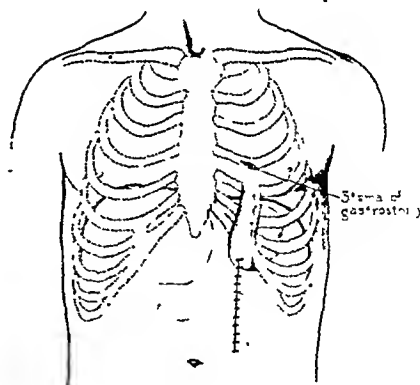
First step. Ligation and division of gastrocolic omentum with preservation of left gastro-epiploic artery. Right gastro-epiploic artery doubly clamped, divided and ligated at pyloric end of stomach. Lower third of stomach to be severed between two long soft clamps (lower clamp not illustrated in order to show line of incision). Another small clamp is placed gently across base of flap at fundus to avoid soiling of operative field.



Second step. Semidiagrammatic sketch to show the construction of the gastrostomy tube. An inner Connell suture and an outer continuous Lembert suture close the stomach and the tube.



Third step. Reconstruction of stomach after formation of tube from greater curvature. The gastrocolic ligament is re-attached to the stomach above the suture line. The tube is 8 to 9 inches in length.



Fourth step. Location of incision for permanent gastrostomy in order to secure valve-like control against leakage by pressure against costal margin. If anastomosis to oesophageal stump is planned, the incision should be in mid-epigastrium, as the stoma then can be placed much higher. Abdominal wound completely closed. The tube emerges through muscle and fascia, then is drawn subcutaneously to the incision on chest selected for the stoma.

FIG. 13. The Beck-Jianu gastrostomy.

then a mid-line epigastric incision is done beginning the incision as high as the xiphoid cartilage. The stomach wall is exposed by the incision. The gastrocolic ligament is divided at a distance of about one inch from the greater curvature taking care to preserve the left gastro-epiploic artery which will serve as the main blood supply of the future gastrostomy tube. The part of the gastrocolic ligament attached to the transverse colon is kept intact, as it may be used to suspend the transverse colon and in some instances to protect the suture line of the stomach. The gastrosplenic ligament is also severed between two ligatures.

The stomach is now clamped longitudinally along the greater curvature using long, soft, rubber-covered clamps, beginning at the antrum and extending high onto the fundus. These clamps are applied about one-third of the way from the greater toward the lesser curvature. At the base of the proposed flap on the fundus, a short rubber-covered clamp is placed gently in a transverse position in order to isolate this segment and to prevent leakage of gastric contents during the operation. This clamp should not be placed too tightly or otherwise it might interfere with circulation. The right gastro-epiploic artery is doubly clamped, severed, and doubly ligated at the distal end of the stomach. It is the left gastro-epiploic artery upon which the circulation of the flap is dependent.

The incision is made between the two clamps extending from the antrum to the fundus. The incision is carried through both the anterior and the posterior stomach walls, the leaves of which are sutured to construct a gastrostomy tube with a lumen at least one inch or more in diameter. Two layers of sutures are employed, the inner a Connell suture of chromic catgut and the outer, a continuous serosal Lembert suture of silk.

If the gastrostomy is to be used only for feeding purposes and instrumentation, the gastrocolic ligament may then be sutured over the suture line in the stomach, particularly at the angle of reflection of the stomach onto the base of the tubed flap. It suspends the transverse colon and furthermore furnishes a defensive guard for the gastric suture line. On the contrary, if the stoma of the gastrostomy is to be placed high on the chest wall or if the tube is delivered through a mid-epigastric incision, the weight of the colon exerts too much tension on the stomach when the gastrocolic ligament is sutured to this organ.

Jianu, in his original article, described the anchorage of the stomach to the upper part of the abdominal wound by interrupted Lembert sutures. This procedure tends to prevent sacculation of the fundus at the base of the tube and to avoid the formation of an hour-glass stomach. It lessens considerably the tension on the tube caused by the weight of a distended stomach. The later authors do not stress this step sufficiently, and many of them have probably not anchored the stomach as outlined by Jianu.

After the anterior and posterior edges of the stomach are sutured together and the suture is continued at the flap to form a closed tube, this goose-neck is gently drawn out through the upper end of the abdominal incision and placed upward over the chest wall in order to ascertain how high it can extend. The tube may be fashioned of selected length. A small transverse incision about one and one-half inches long is made after the site for the stoma has been selected in this way. The surgeon then burrows through the subcutaneous tissue from this skin incision down over the ribs until a Kelly clamp enters the subcutaneous plane of the abdominal incision. This subcutaneous channel is dilated until it is much larger than the tube, otherwise it may contract on healing and constrict the tube sufficiently to interfere with its blood supply. The surgeon introduces the clamp through the incision to the stoma, grasps with this clamp the extremity of the gastrostomy tube and draws it through this subcutaneous channel until the end of the tube reaches the incision in the skin. Infection of the subcutaneous channel may be avoided by temporarily inverting the tip of the goose-neck tube by two sutures, or the end of the tube may be covered by a fingercot or condom. After the tube has been delivered through the incision for the stoma it may be left unopened for twenty-four to forty-eight hours at which time the occluding sutures are removed.

There is considerable risk of sacculation of the intra-abdominal portion of the tube and subsequent difficulty in feeding if the tube is left slack and is not pulled up snugly. The blood supply runs in a longitudinal direction, therefore, any suture in the extremity of the tube should be placed in this same direction, otherwise it may interfere with the blood supply of the tip with resultant ischemic necrosis.

In the original Jianu operation on dogs, the abdominal incision was extended upward onto the chest as high as the tube would reach. Then the skin incision was sutured over the tube. The danger of infection is probably greater with such an extended skin wound and

its subsequent sutures than is the case in which the tube is carried to the surface through a long subcutaneous channel.

The abdominal wound is closed in layers. The peritoneum and split rectus muscle are closed by continuous, plain, catgut sutures. The fascia is closed by interrupted catgut sutures, which fit snugly but not too tightly around the tube. The skin is completely closed preferably by interrupted sutures in order to allow for drainage if it is necessary during the healing of the wound. Thus the tube extends through the peritoneal, muscular and fascial layers, but does not extend through the skin of the abdominal incision. A small drain is placed subcutaneously at the lower end of the abdominal wound.

The completed gastrostomy is ideal in every respect. The stoma is situated so high above the stomach that regurgitation of food and gastric juice never occurs. The tube is bent upward over the costal margin or over the xiphoid cartilage and in so doing obstructs the lumen sufficiently to serve as a very good valve, and in this way also prevents the regurgitation of food through the gastrostomy. The blood supply is adequate and even the extremities of a very long tube will never suffer from ischemia. The rectus muscle may also serve as a sphincter. The tube has a much larger lumen than occurs in the Janeway or Depage gastrostomy, and on this account it is possible to give semi-solid food such as ground meat. Pureed vegetables and ground foods may later be given through this gastrostomy, using a small pressure-gun for introduction.

A rubber catheter of No. 12 to No. 16 French is left in the gastrostomy during the first ten days. Water and peptonized milk are given immediately after the operation and a liquid and semi-solid diet increased quickly until the patient is soon on a well balanced, high-caloric, high-vitamin diet.

The Beck-Jianu operation is not difficult to perform nor associated with great danger to life. Food is placed into the fundus rather than the pyloric extremity of the stomach. Retrograde bouginage and intracavitary instrumentation are readily performed through a tract of this calibre.

5. A GASTROINTESTINAL AIR-VALVE AND NONLEAK GASTROSTOMY FEEDING TUBE

The bane of existence for the individual with a fistula anywhere within the gastrointestinal tract is leakage. The condition of the patient with a raw, excoriated, red, excessively tender and partly digested abdominal wall, extending for 2 to 4 inches around an incompetent fistulous tract, is often one of intense misery. Excoriations of lesser extent cause diminished discomfort, but such leakage is never pleasant. The methods utilized in attempts to prevent this occurrence have been numerous yet none has proved wholly successful. To enumerate and describe these efforts would require several pages of text. Their very number, and the escape of content that still occurs despite them, testifies that further search for additional means of control must still continue.

The fundamental requirements to be met may be summarized as follows:

1. Complete, continuous retention of all discharges, both fluid and gaseous.
2. The avoidance of bulky, inconvenient and costly equipment.
3. Utilization of a device that the patient himself can easily manage.
4. Provision of a means for relaxation of this control, where desired, in order to give access to the lumen of the gastrointestinal tract. Within the upper segments of the canal this access is for purposes of feeding, and within the lower portions of the alimentary tract the purpose is for irrigation and cleansing.
5. Noninterference with normal function of the part.

The particular aims of various efforts made at fistulous tract control and reasons why they have failed fully to meet all of the desiderata outlined are readily apparent as certain of the most common of these are enumerated. For example, striated muscles have been wrapped about the distal end of enteral fistulas in an attempt to furnish the patient with voluntary muscular control. Yet failure results because striated muscles cannot be contracted quickly enough, or tightly enough, nor can voluntary contraction be long maintained. Again, attempts have been made to construct tortuous fistulas and long, angulated tracts; yet this very tortuosity, if indeed successfully created, seriously interferes with such objec-

tives as feeding or irrigation, and surgical tubes are difficult to replace once they have become dislodged.¹⁴ And again, cones of invaginated gastric wall and other valvular visceral traps have been

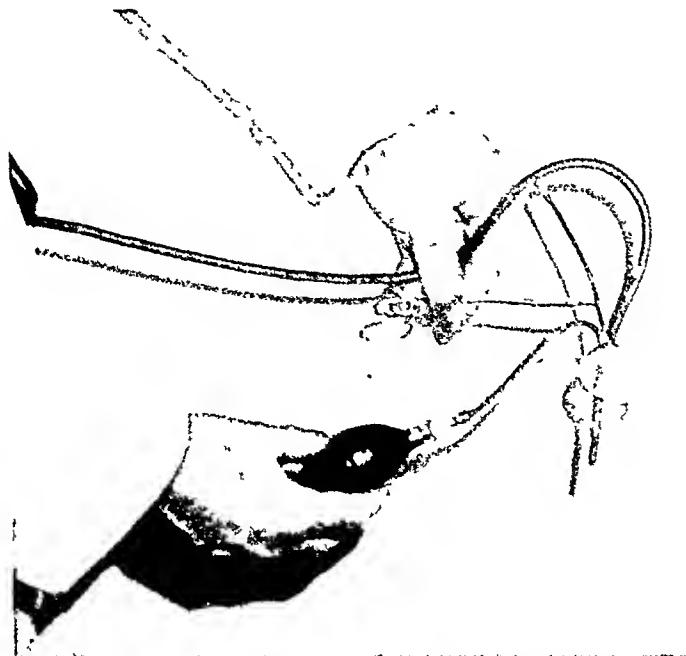


FIG. 14. A, the nonleak gastrostomy air-valve and feeding tube. The right holds an inflation bulb for distending the balloon. The left hand holds the feeding tube and a clamp which is attached to a solid rubber cord used to hold the inflated bag in contact with the anterior gastric wall while in situ. The feeding tube is locked in any position desired when the unit is inflated.

constructed, as in the Senn and Frank operations. But the original artificial sphincters and obliquities do not long persist, and it is amply shown that Nature with her smooth muscle sphincters cannot easily be imitated. And still again, a wide variety of pads and bags for the outside of the body have been devised to collect fluid discharges. But even here offensive odors persist and some amount of contamination and gaseous or fluid leak seems unavoidable, while body contours are often distorted by bulky external appliances. In individual instances many of these efforts have met with success, but in general they have been most unsatisfactory for routine use so far as meeting all basic requirements is concerned. It is not uncommon to find patients developing suicidal tendencies, and larger numbers who are completely discouraged because of their discomfort or chagrin.

The difficulties just reviewed will, in the main, not be found true with the method to be described. A new type of sphincteric control for gastric and intestinal fistulas by the use of air-valves is illus-

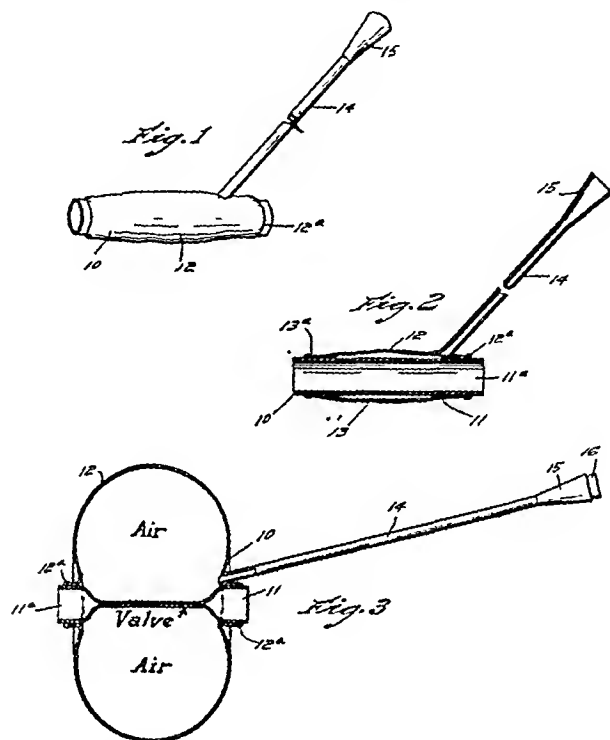


FIG. 14. B, details of construction of the nonleak gastrointestinal air-valve. (1) The deflated unit; (2) cross-section of the deflated unit; (3) the inflated unit, showing action of the air to close the central core of soft rubber construction; 10, junction of inner and outer walls for one-piece construction; 11, the inner soft rubber core; 11a, lumen of core; 12, outer wall; 12a, union of outer wall with core wall; 13 and 13a, same as 12 and 12a; 14, the inflation canal; 15, conical tip for air or fluid inflation; 16, plug to retain balloon contents.

trated in Figure 14. For a considerable period of time rigid rubber tubes surrounded by distensible balloons have been employed to advantage to act as inflation plugs; but the device here described, so far as we are aware, introduces an entirely new principle for gastrointestinal work.

Of what does this air-valve principle consist? A compressible rubber tube, as a Penrose drain, is incorporated in the interior of an inflation bag, in place of the rigid and noncompressible tube. And

how does this function? When such a balloon is distended, the soft rubber tube incorporated within its interior becomes tightly compressed by the surrounding air, creating a water-tight and air-tight valve. The central passage of this device is now securely closed, imitating the prolonged sphincteric action of smooth muscle. Deflation of the outer balloon again re-opens the inner passage, leaving a lumen of full diameter, accessible and ready for immediate use. By this air-valve principle it is possible to close the lumen and to maintain it as closed so long as desired, but then to open instantly the lumen to full diameter when *this* is wanted. All of the aims previously outlined are adequately met, and no better copy of natural sphincteric action could be easily conceived. The apparatus is small, convenient, of low cost and is readily managed by the patient himself.

Air-valves of this type are ideal for the control of gastrostomy fistulous tracts. These valves make it possible to construct gastrostomy stomas of considerably increased diameters—an important feature for intracavitary research and therapy. Operations may be performed at an early stage in the disease since there is less hesitation about giving the patient such an external fistula. These individuals need no longer progress to advanced stages of dehydration and starvation; and direct therapeutic maneuvers within the gastric lumen can be carried out at the most favorable period possible.

The feeding tube is incorporated in the device during manufacture. The accompanying illustration is self-explanatory. The non-leak gastrostomy units are of one-piece construction. They are made of special rubber composition of durable character. Repeated sterilization by boiling causes no deterioration. A notable feature in manufacture is the fact that the central soft rubber tubing is turned back over the distensible balloon in such a fashion that the rubber coatings are all continuous. The central passage has a diameter of one-half an inch and the feeding tube is so incorporated in the unit that its inner tip lies within the inner third of the air-valve. The outer tip of the feeding tube is conical in shape to facilitate the introduction of syringes and glass connectors. Inflation is secured by a blood-pressure bulb and maintained by means of a metallic set-screw. Various diameters of inflation can be secured by selecting between numerous valves of slightly different design. Among these the balloons vary from pear-shaped, to pessary-shaped models. In practical use, the compression screw-tip is supported above the dermal

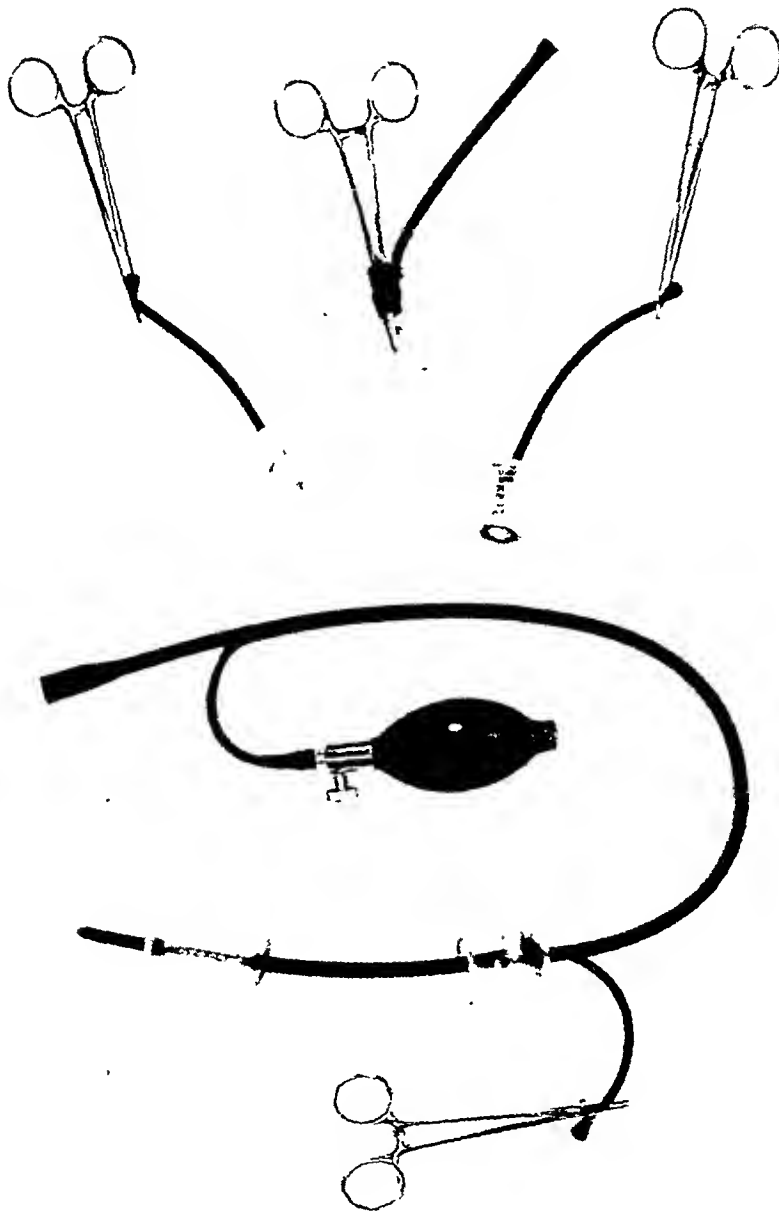


FIG. 15. The nonleak gastrointestinal air-valve for plugging gastric and intestinal stomas. Upper center figure: illustrates size of deflated unit. A hemostat traverses the lumen of the soft rubber central core. Upper left: the balloon is inflated which collapses the central core to form a sphincter. Upper right: a side view showing the sphincteric action of the air valve, imitating smooth muscle control. Lower figure: an air-valve has been slipped over a radium applicator before inflation. The inflated air-valve locks the unit at any selected level. This arrangement proves useful for radiation therapy within the rectum, or for locking a gastrostomy feeding tube in place. (See text.)

surface by a washer of rubber or of folded adhesive plaster. Outward traction on the inflated balloon pulls the unit against the anterior gastric wall with any desired degree of firmness. A wooden or lead stopper is supplied for the outer tip of the feeding tube; but leakage from this site is only possible before balloon inflation. A special inserting device, similar to a vaginal diaphragm insertor, may be procured but this refinement is needless. Models of these nonleak gastrostomy feeding tubes and allied air-valves have been supplied for us by the Davol Rubber Company, of Providence, Rhode Island.

The utility of these air-valves of different design, in gastroenterological work could not easily be overemphasized. An accompanying plate illustrates certain other uses, such as that of control of a jejunostomy fistula, an ileostomy, a colostomy, et cetera. One important application is that of locking multiple-lumened radium applicators in situ within the rectum. (Fig. 15.) It should be pointed out that anesthetists already make use of this type of pneumatic control for occlusion of the bronchi, and it was from this prior use that the present extension of the air-valve principle to gastroenterological work first suggested itself.

6. GASTRIC MODELS AS AN AID TO ENDOGASTRIC RESEARCH

Exact replicas of normal and diseased stomachs made from postmortem specimens are valuable aids to endogastric research. Models of stomach, terminal esophagus, and duodenum as used in this particular study were devised in conjunction with Dr. William Smith of the Laytexture Company of New York. Salient points on their manufacture and use will be briefly given because of the many ways in which these ingenious artificial organs of rubber composition may be employed in cancer work generally.

Plaster casts which are made from the submitted postmortem specimens or hand-sculptured from measurement, are dipped in a special solution of laytex and treated in a casting oven. The models thus secured may be of any desired wall thickness and pliability and are available in a number of different textures. Both the inner and the outer visceral walls are reproduced. The most minute as well as the gross structural details of the original specimens are revealed. The replicas have life-long durability. They are waterproof and may be colored during their manufacture or hand-tinted thereafter. Certain of these models were given transparent windows, others were furnished with goose-neck projections, and still others with facilities for the insertion, at will, of detachable gastric lesions of similar composition. Laytexture organs can be cut, sutured, fenestrated, stretched and otherwise manipulated without loss of their remarkable durability. As many reduplications as desired may be obtained from a single specimen. Manufacturing costs are thus kept at unexpectedly low levels. The many unique features of this particular composition are apparent as these models are compared with others of wax, wood, clay, plaster, papier mache and other available materials.

Some of the uses subserved by these synthetic organs will be cited without further comment. Methods for alignment of radium applicators were studied; suitable shapes, lengths, diameters, and tensile strengths of endogastric balloons were tested; the air-tight and water-tight value of gastrostomy air-valves were put to practical trial; the focal lengths of lens systems were measured; photographic equipment was used under simulated clinical conditions; electro-surgical cutting and coagulating instruments were employed both

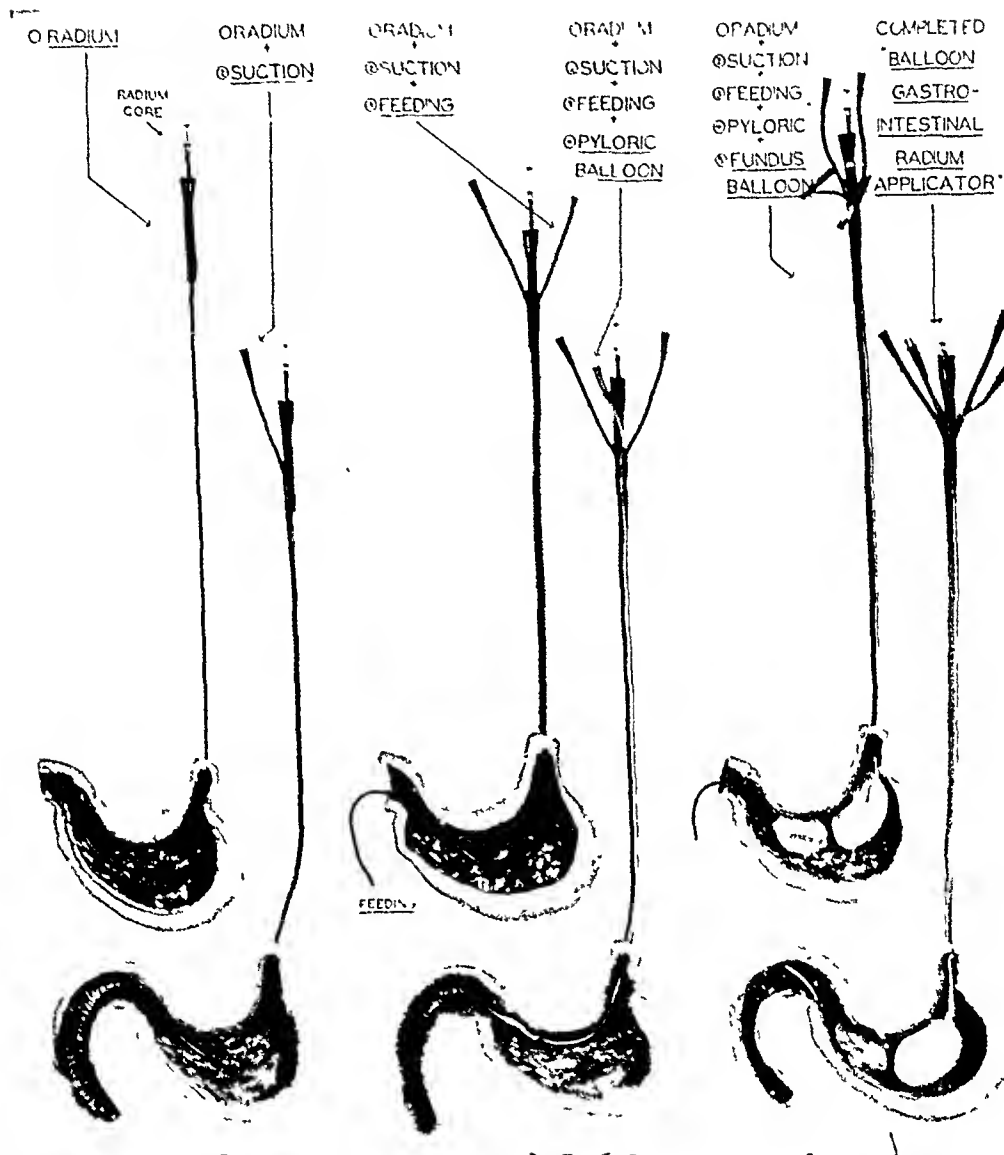


FIG. 16. Gastric models of special rubber composition. These models are made by the "laytexture process" and have many uses in studies of endogastric instrumentation and irradiation. The six models here shown illustrate the construction of the five-lumened gastrointestinal radium applicator described in Part II of this monograph. Each individual lumen is shown in a composition stomach, to demonstrate its separate function. The sixth model shows the completed unit, the five lumens coated to form a single 6 by 8 mm. tube.

under water and in air at different temperature ranges. Both peroral and retrograde approaches were studied. Suffice it to say that a wide variety of teaching and research aims are admirably met by these composition stomachs. The accompanying illustration of six of these Laytexture reproductions discloses the construction of the five-lumened gastrointestinal applicator for radiation therapy as first introduced at an exhibit before the Radiological Section of the Southern Medical Association in Louisville, Kentucky in November, 1940. (Fig. 16.)

By embedding these gastric models in a suitable medium, such as butter, with the activated radium core in place, the discoloring effect of gamma radiations may be studied and by use of suitable phantoms the exact amount of radiant energy to reach any part of a given tumor or its adjacent lymphnode bed, is ascertainable. Thus scientific precision may be secured for intragastric radium therapy, eliminating uncertainty and guess-work. The figures used in the dosimetry studies for this form of irradiation as discussed in another portion of this monograph were obtained from pre-existing tables through the kindness of Dr. Edith Quimby. From these valuable data the number of threshold erythema doses of radiant energy to reach all parts of a stomach cancer of known dimensions at a single treatment of fixed type can be plotted and the radiotherapeutic value of this form of treatment stated in its physical terms.

7. ELECTROSURGICAL BIOPSY TOOLS AND ENDOGASTRIC RESECTOSCOPES

Among lesions that can simulate malignant epithelial tumors of the stomach are benign ulcers, polyps, perigastric adhesions, exogastric masses, various types of gastritis, Hodgkin's disease of the stomach, gastric syphilis and lymphosarcoma. Microscopic proof of diagnosis here, as in the management of suspected malignant tumors of any site, is a matter of major importance. Gastric lesions, however, present unusual difficulties in this regard. The method of aspiration biopsy which has so admirably solved the problem for many localities, is of no value for primary gastric tumors. The flexible gastroscope has not yet been developed to a point where biopsy specimens can be secured by this means. The peritoneoscope is applicable for securing specimens only in the presence of serosal implants; and even here tissue is removed with considerable trepidation because of fear of uncontrollable hemorrhage or perforation of the viscus. How often it is found, in some particularly important case such as one of unexpected response to irradiation or an instance of unusually long postoperative survival, that microscopic proof of cancer has never been obtained.

A positive preoperative diagnosis can be secured in a fair percentage of cases by use of an esophagoscope or rigid oral instrument providing the tumors dealt with are located at or near the cardiac orifice. A long grasping forceps with a short biopsy bite is utilized and minute fragments thus secured. Yet not infrequently normal mucosa is obtained despite the actual presence of cancer. Again, it is a relatively simple procedure to excise a fragment of suspected lymphnode, serosal gastric outgrowth, or hepatic nodule, by means of a sharp scalpel at time of laparotomy. But to secure tissue from the primary gastric tumor in the absence of these secondary extensions entails gastrostomy with the danger of transecting invaded gastric wall inviting subsequent insecurity of closure. When a gastrectomy can be performed the question of biopsy becomes less important since the gross specimen provides the diagnosis and serial sections are always made. In instances in which a large fragment of tumor or mucous membrane is cut away under direct vision within a surgically exposed stomach it is often necessary to pass a suture-ligature at once through this site to control bleeding. This fact

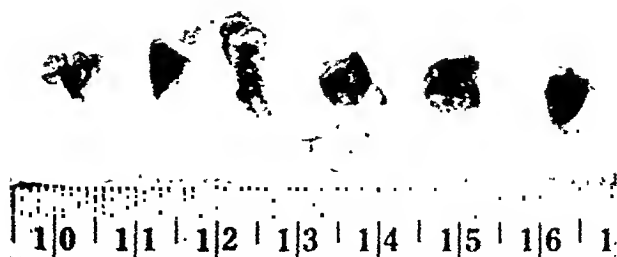


FIG. 17. Specimens of stomach cancer and adjacent mucosa obtained from a single stomach, using an electrosurgical resectoscope with coagulation current. Note the size of the specimens and the superficial nature of the electrocoagulation effect.

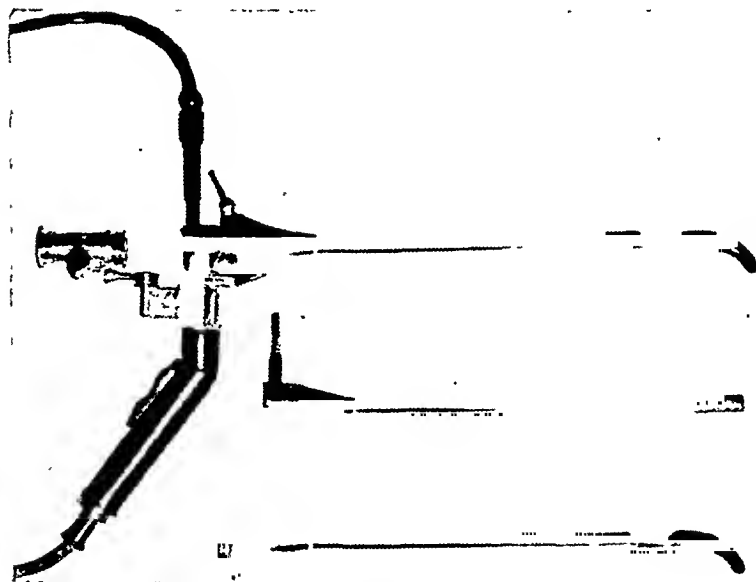


FIG. 18. The intragastric electrosurgical biopsy punch. The portion of tumor or gastric mucosa to be excised enters the fenestration in the outer endoscopic tube. It is observed in natural size and color through the focusing telescope. The resector is the central tube in the figure. The cutting is done with a hollow steel disc electrically heated at the tip of the instrument. The specimen is lodged in a lava bed which protects it from excessive action of heat.

inevitably influences the operator when he plans to attempt an endoscopic excision of a specimen of similar size. In an organ so vascular it is probable that no method can be completely safe with



FIG. 19. The intragastric electrosurgical punch in clinical use. The current is controlled by a foot switch. The specimen is removed by a quick rotary motion of the instrument. The site of excision is left dry and coated by a thin electrocoagulation surface. Any tissue observed through the lumen of the instrument can be secured as the biopsy specimen.

regard to primary or delayed bleeding. Hence even the presence of a wide gastrostomy canal by no means ensures the removal of serial or multiple biopsy specimens with the facility that might be anticipated. Poor visibility, difficulties as to orientation, possible perforation, inadequate tools and fear of hemorrhage are among deterrent factors.

On the Gastric Service of The Memorial Hospital electrosurgical resectors and punches of the type now used for transurethral prostatectomy are being tested as new intragastric equipment. Figure 17 depicts the large tissue fragments and mucosal specimens that can be secured with ease and safety as to immediate hemorrhage by use of electrocoagulating instruments. There seems little question but that electrosurgical tools of the basic design of those here illustrated will be modified to form specialized endogastric equipment.

We find no reference to a prior use of prostatic resectoscopes within the stomach or of this type of instrument for procuring gastric specimens. Modifications of design which at once suggest themselves

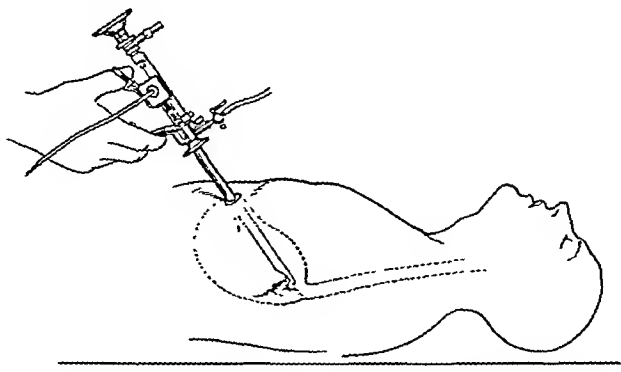


FIG. 20. Diagrammatic view of the technic for obtaining a biopsy specimen from a carcinoma of the cardia, using the electro-surgical punch.

are numerous and certain of these have already been made. Included are, endoscopic tubes of compound lumens to furnish continuous suction at the instrument tip, a reduction in calibre of the punches and snares to diminish the size of the tissue removed, an arrangement to remove smoke and fumes by a rapid circulation of air within the stomach, construction of the tools to provide against loss of the tissue fragments excised, a consideration neither necessary nor always expedient for prostatic work.

The electro-surgical resector of diminished lumen made for this service by the Cameron Surgical Specialty Company is illustrated in Figures 18 and 19. The Nesbit modification of the Stern-McCarthy resectoscope furnished for these studies by the American Cystoscope Company is shown in Figure 20. The electro-surgical cabinets, such as the Cameron Cauterodyne which furnish the cutting and coagulating currents, will not be described in detail since such information can be secured from the trade literature.

TECHNIC FOR OBTAINING BIOPSY SPECIMENS WITH THE ELECTROSURGICAL PUNCH

(Use of a modified Cameron electropstatic resector will be described.) The preparation and position of the patient, dilation and instrumentation of the gastrostomy passage, and the cleansing and inspection of the gastric lumen, all are carried out as outlined

under the heading "The Technic of Anterior Gastroscopey." The metal plate attached to an indifferent electrode is placed in contact with the patient's skin. The active electrode is fastened to its binding post at the base of the electrosurgical resector with a foot-switch introduced into this circuit. The current is arranged for delivery of a full coagulating current, using a Cameron Cauterodyne. With everything thus in readiness the resector, held to its maximum depth within its outer or encircling endoscopic tubes (Fig. 18) is introduced into the gastric lumen and manipulated until the predetermined position has been reached from which the specimen is desired. The telescopic eyepiece is now swung on its swivel into the observational position and the central punch or electrosurgical resector is partially withdrawn. As this is done a portion of tumor or mucous membrane enters the lumen of the instrument from the window or fenestration in the outer endoscopic tube. The position of this window is indicated to the operator by a white dot situated near the outer end of the endoscopic tube. Any fragment of tissue which enters this window and can be seen by the observer within the lumen of the instrument will be removed as the biopsy specimen. Hence the operator is able to control the size of the fragment to be taken away and can note its color and consistency before it is excised. Removal is effected by a combined cutting and boring motion of the instrument; while the coagulating current acts chiefly to sear the excision bed to prevent hemorrhage. When the desired fragment of tissue is under direct vision in the lumen of the instrument, the operator steps on the foot switch, simultaneously forcing the resector core forward into the tip of the encircling endoscopic tube. The motion is one of pressure and rotation. The instrument is turned through a 90 degree arc as it advances, then counterrotated to its original position. The more rapid the motion the less the coagulation effect and damage to the specimen. The entire instrument, resector and endoscope, is removed at once. The tissue obtained is lodged within a special lava bed provided in the resector to protect the fragment from excessive heat. Less than a millimeter of its outer coat is seared, the remainder being unimpaired for microscopic study. (Figs. 21 and 22.) The specimen is removed from the resector by forceps and placed in 10 per cent formalin solution. The site of removal is found on inspection to be dry and covered by a grey coagulated surface. No secondary treatment of the donor site is required. The entire thickness of the stomach wall is unable to enter the lateral fenestration of the instru-



FIG. 21. Microphotographs of biopsy specimens removed by the intragastric electrosurgical resector. Note the very thin eschar and the unimpaired character of the specimen thus removed for microscopic examination. (Specimens prepared through the kindness of Dr. Fred Stewart.)

ment so that perforation of the stomach is impossible. Other types of electrosurgical tools which necessitate a cutting rather than a coagulating current present certain dangers since the depth of action

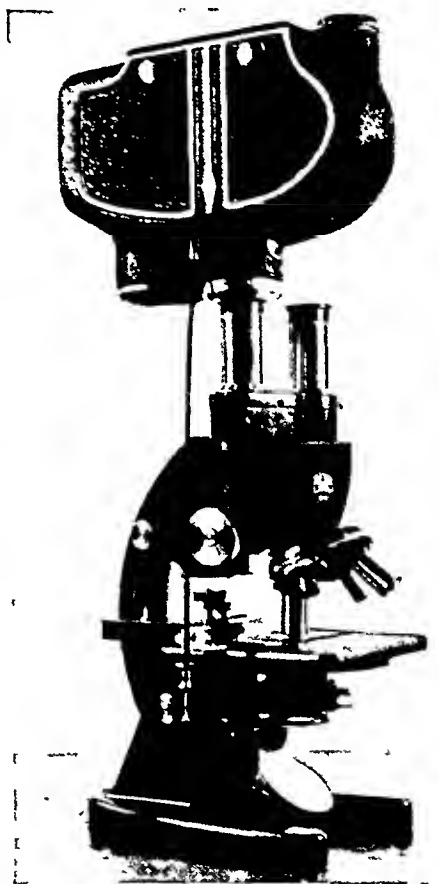


FIG. 22. Use of the clinical color-flash camera for obtaining microphotographs.

of the current is difficult to control. In this study only coagulating currents have been used while tools for cutting currents have been utilized for their observational purposes exclusively.

These few paragraphs on the intragastric use of resectoscopes and punches should not be construed as advocacy of electrosurgical treatment for stomach cancers. Studies of the latter subject have been made for several years by Strauss,¹⁵ of Chicago and his proposed technic of therapy and reported results have recently been summarized elsewhere.¹⁶ Proper evaluation of this nonexcisional form of therapy will require a considerable period of time, although the preliminary reports furnished by Strauss are favorable. Pack and

others have treated multiple polyps of the stomach by use of the electrosurgical snare passed through a gastrostomy stoma. It is probable that the additional electrosurgical instruments here illustrated will prove of service for further clinical experimentation along these lines. The vascularity of the stomach calls for marked caution in any form of intracavitary excision unless the viscus is fully exposed, and the only use that can be recommended from the present study of these instruments is that of removing tissue for biopsy examinations.

8. EXTRAPERITONEAL CLOSURE OF GASTRIC MUCOUS FISTULAS

Gastrostomies created for the purpose of intracavitary study or treatment need not be made permanent. Such mucous-lined communications with the body surface can readily be closed by a simple extraperitoneal operation when no longer required. Up to the present time gastrostomy closures have seldom been performed; for a gastrostomy has been looked upon as almost exclusively a pre-terminal measure where an early inevitable death must be anticipated despite the forestalling of starvation by this purely palliative step. And even when the feeding passage has been created for cardiospasm or a benign esophageal stricture and a subsequent closure is made, this secondary operation often has been made an extensive intraperitoneal procedure. Wider acquaintance with the extraperitoneal technic of closure should go far toward dispelling the concept that to create a gastrostomy goose-neck tract represents a final and irreversible change or that to effect a closure must carry considerable additional hazard. There is reason to believe that the use of gastrostomies for purposes other than feeding will gain increasing favor. The results already attained in cancer therapy through the aid of suprapubic cystotomy, proctotomy, pharyngotomy and other similar operations which give surface exposure of visceral lumens and visual access lend support to such a view. Certain of the attainments from low voltage "contact" roentgen ray therapy and electrosurgical measures have already been referred to and clinical studies of similar methods for gastric carcinoma are being actively pursued. The importance of mucosal investigations, likewise, with reference to the etiology of cancer of the stomach is recognized to demand additional methods for endogastric visualization. These considerations enhance the significance of methods for the control of gastrostomy tracts and for their safe obliteration once their purpose has been served.

A lipped fistula, or one with a direct union between mucosa and skin will never close spontaneously. Operative closure is always required whenever mucosa and skin are in contact at any portion of the stoma. The reason why a gastrostomy canal can be removed without entering the general peritoneal cavity is because the anterior

gastric wall is firmly adherent to the parietal peritoneum over a considerable area in virtually every case.

Operative Technic. The steps for an extraperitoneal closure are as follows: The skin is incised by an elliptical incision made 2 to 3 mm. beyond the margins of the gastrostomy stoma. The dissection is carried down through the subcutaneous fat to, but not through, the rectus fascia. The redundant portion of the gastrostomy stoma with its everted mucosal margin or lip is now simply excised transversely. The mucosa is inverted by two or three interrupted mattress sutures of fine chromicized catgut using a curved atraumatic needle. A second layer of two or three similar sutures is taken in the sero-muscular coat. The skin is then closed by one or two clips or with two black silk sutures, leaving a tiny iodoform wick in place, which is withdrawn in forty-eight hours. By this simple means, the size of the wound is minimal; infection seldom occurs as there is a certain degree of local tissue immunity. Furthermore, the closed stoma is immediately beneath a depressed dimple in the scar, so that it can be readily located in the future and opened by a stab wound if a subsequent need for a gastrostomy occurs. The operation is done under local anesthesia.

Part II
SURGICAL AIDS TO ENDOGASTRIC
IRRADIATION

1. INTRODUCTION

Remarkably little has been claimed to the present time concerning the value of radiation therapy for the treatment of cancer of the stomach. Technical difficulties of apparently insuperable magnitude have persistently blocked the pathway to curative irradiation for carcinomas of this particular site. Because of its location, deep within the peritoneal cavity, the stomach has remained inaccessible to the radiation therapist, save for the external applications of roentgen rays and radium. All attempts at intracavitary and intramural treatment have thus far required exploratory laparotomy and types of associated operative intervention. But agreement is general that unless a gastric cancer can be removed surgically there is now no reasonable ground on which to anticipate the attainment of cure. From no source has an accepted claim been made of any truly curative value in either external radiation alone or in combined radiosurgical therapy. The only method of treatment that can as yet be depended upon to yield a predictable percentage of definitive cures, no matter how slight, is excisional surgery.

The amount of palliation, furthermore, to be secured by non-excisional modes of treatment has proven forlorn in the extreme. Something of the current attitude toward radiation therapy for gastric cancer is clearly reflected in the fact that throughout the country as a whole, as judged from the medical literature on the subject, not more than a fraction of 1 per cent of patients with the disease now receive irradiation in any form. It has been reliably estimated that over the entire period of development of radiation therapy, during which it has become the standard procedure and treatment of choice in the management of malignant neoplastic diseases of a number of sites, not over 1/1000 of 1 per cent (0.001) of patients with gastric cancers have ever been accorded radiation treatments by any technic of application.

Faced with such a situation certain queries naturally arise. Why has radiation therapy for gastric cancer lagged so appreciably behind the impressive successes of radiation methods in the control of malignant tumors in other organs and sites? Have conditions with regard to the total dosage of radiant energy delivered, and details as to the fractionation and spacing of such total dosage, as found necessary for the successful control or destruction of adeno-

carcinomas of other localities and internal viscera been fully reproduced in attempting the eradication of gastric cancers? And if not, what problems have arisen to prevent such an exact reduplication of these fixed and favored conditions?

An index to the answers to these significant questions is provided in a brief survey of the history of gastric irradiation to the present time.

A. HISTORY OF RADIATION THERAPY FOR GASTRIC CARCINOMA

Within a few months of the discovery of x-rays by Wilhelm Roentgen, a patient with gastric cancer had been treated by roentgen-ray exposures. The case, reported by the Frenchman, Despeignes, in 1896, constituted the first internal organ to be given therapy by either x-rays or radium.¹⁷ Lack of knowledge of the equipment used and of all physical factors involved makes it impossible to estimate the tissue dose reaching the neoplasm. Eighty exposures were made, giving treatments of from fifteen to thirty minutes each, twice daily.

Notwithstanding this initial and early instance of radiation treatment, records can be found of only two individuals with stomach cancers who received radiation therapy prior to the time of the first World War, or until 1914. This second report was published by Wickham and Degrais (1914). Here a gastroenterostomy was performed and a fistulous tract was left between the pyloric antrum and the body surface.¹⁸ Through this fistula a sound containing radium was inserted periodically for an interval of three months. A palpable epigastric mass also received roentgen-ray exposures. It is recorded that both the patient of Despeignes, treated by x-rays alone, and that of Wickham and DeGrais, treated by x-rays plus radium, showed marked symptomatic improvement, yet the length of life from outset of treatment until death remains unknown.

In 1918, Janeway of The Memorial Hospital inserted a radium applicator into a stomach at the time of operation.¹⁹ He subsequently subjected six other patients with the disease to external applications of radium, reporting favorably on the improvement in symptoms observed.

However, it appears probable, from this paucity of reports, that between the years 1895 when x-rays were discovered, and 1920 or the outset of the third decade of the present century, the number of patients with stomach cancer, who were accorded experimental

radiation therapy, did not exceed two or three persons among every million harboring the disease.

Radiation Therapy at The Memorial Hospital. It seems justifiable to note that over half of the cases from published records on experimental radiation therapy for cancers of the stomach have been treated at The Memorial Hospital. The names of Janeway, Pack, Quimby, Scharnagel, McNeer and Loizeaux constitute a considerable portion of those connected with the study of this subject. Commenting on the scant end results obtained to the present under the doses of radiant energy thus far delivered to the stomach, Pack has written "Whatever advantages and benefits have occurred, are over and above what could have been given by surgical measures alone, by the very definition of the term inoperable."²⁰ Thus it is but natural, under the stimulus of this unabated institutional interest from the time of Janeway that we should continue at The Memorial Hospital the investigation of newly developed technics of radiation therapy for this organ, despite all previously disheartening findings from elsewhere. It is in this spirit of leaving no stone unturned in a search for additional aids for patients with gastric carcinomas definitely outside the sphere of curative surgery that these further researches on intracavitary methods are now being pursued.

In 1922, Levin of New York placed unfiltered glass radon capsules into a few gastrointestinal tumors, but such therapy was never widely employed and caustic beta radiation reactions were severe.²¹ Three years thereafter Failla introduced the capillary gold radon seed²² and a number of authors have subsequently reported on the occasional use of interstitial implants either made transperitoneally at time of operation, or transmucosally through gastrostomy stomas. To the present time, nevertheless, there is no clear record from any author or from any institution recounting as many as a score of such treatments; and interstitial radiation therapy for gastric tumors has been decidedly sporadic. Powerful machines, furthermore, for delivering deeply penetrating x-rays are of relatively recent advent.

The Year Books of Radiology from the first to the current volume (1932 to 1940) in their aggregate furnish records of only fifty-two patients with stomach cancer treated by any type of irradiation, an average of six and one-half patients a year, for World literature.

An accompanying table summarizes articles on radiation therapy listed in the Quarterly Cumulative Index Medicus. It will be observed

END RESULTS OF RADIATION THERAPY FOR GASTRIC CANCER

Year of Report	Author	No. of Patients Treated	Method	Improvement	
				Subjective	Objective
1896	Despeignes	1	Roentgen exposure	Pain disappeared	Reduction size of tumor
1914	Wickham and Degrais	1	Insertion of radium after gastroenterostomy	For 18 mo.	
1918	Janeway	7	6 by external irradiation; 1 by insertion of radium after gastroenterostomy	Slight	
1922	Levin		Treatment given by insertion of bare glass capillary tubes of radon twice through two different laparotomy wounds	Roentgen and radium externally, ineffective; improvement in some cases with author's method	In 2, the tumor disappeared for 8-12 mo.
1923	Evans and Leucutia	25	High voltage roentgen rays	All symptomatically relieved	
1923	Cahen	2	External radium therapy; moulages	Symptomatically improved for 10 mo.	
1928	Schmidt	30	Roentgen therapy	1 lived for 3 yr.	Tumor disappeared in both
1929	Holfelder	2	Roentgen therapy	1 lived 2½, 1 lived, 1 yr	
1931	Holfelder	100	Using compression diaphragm to exclude organs overlying tumor by pressure	2 lived 1 yr., 2 for 6 mo.	
1932	Scholz	1	Irradiation of barium-filled stomach after gastroenterostomy	Well for 7 yr	Normal stomach on roentgen examination
1933	Gosset, Monod and Regaud	31	Gamma rays more effective therapeutically than roentgen rays; treatment limited to external application of radium	17, no improvement; 7, improved with noticeable prolongation of life; 1 cured 6½ yr., 1 for 33, 1 for 11, 1 for 12, 1 for 16 and 1 for 21 mo.	
1935	Levin	6	Operation and gold seeds	1 living at 3 yr., 8 mo.; 1 living at 16 mo.	
1935	Pack, Scharnagel, Quimby and Loizeaux	60	External irradiation with high voltage roentgen rays and radium element pack; interstitial irradiation using gold radon seeds	1 (with lymphoma) living 6 yr. after treatment, well; 1 for 3 yr.; 2 for 2 yr.; 6 were relieved for a short time, but succumbed to recurrent activity, or residual cancer, or to distant metastasis; of these, 1 lived 20 mo., 1 for 18 mo.	
1936	Hayer	30	Roentgen therapy	4 living beyond 1 yr.; 1 living for 30 mo.	
1937	Pack and McNeer	268	Same technic as above	Twenty per cent of patients received worth while palliation; 5 per cent of patients obtained excellent benefit	
1938	Ragelsberger	22	Roentgen therapy	Longest survival—17 mo.	
1940	Pack and Livingston	100	(See Pack et al., 1937) 2 cases of Intracavitary "Contact" roentgen therapy (see text)	End results as in 1937 series (see text on Intracavitary Treatment)	

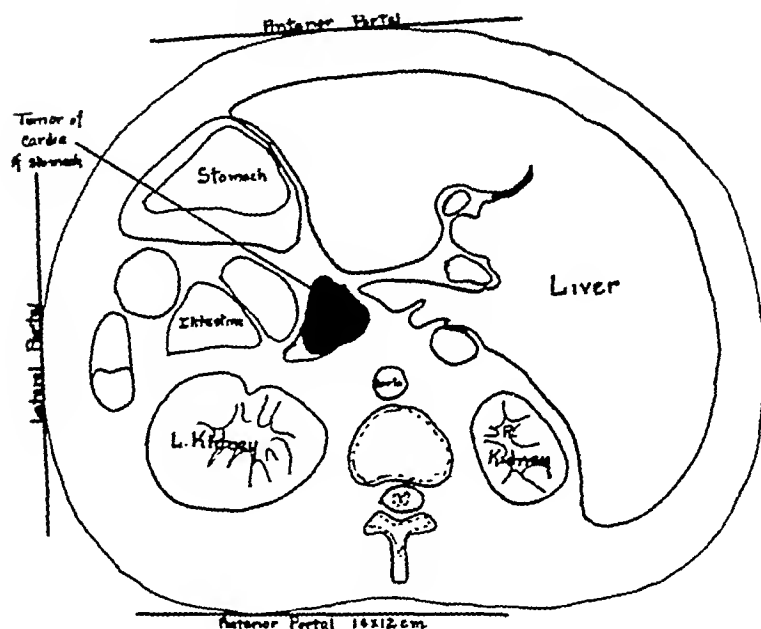
at a glance that the total number of patients to receive radiation therapy was less than 700 in the entire half century of the history of radiation methods. The only records noted wherein more than sixty individuals were studied are those of Holdfelder in Germany in 1931 (100 cases),²³ of Pack and McNeer of New York in 1937 (268 cases),²⁴ and of Pack and Livingston in 1940 (100 cases).²⁰ The communications listed deal with treatments by teleradium, high voltage roentgen-rays, gold seed radon implantations, and the use of a wide variety of moulages, sounds, bougies and catheters. Yet *there is no record of a single patient with verified gastric carcinoma treated by any form of radiation therapy, without gastrectomy, who has survived treatment by so long as three years.*

Improvements thus far obtained must be measured in terms of symptomatic relief or of weeks of added life rather than on a basis of long months or years of definitive cure. Pack states "Although present methods of radiation therapy offer little of curative value one in every five patients treated receives worth-while palliation. In one patient out of twenty, the results of treatment are remarkable and definitely beneficial." Cancers of the cardiac end of the stomach, are more radiosensitive than are those of pars media or pyloric antrum. Radiation therapy for nonepithelial malignant tumors of the stomach (lymphoma, sarcoma), however, whether treated by high voltage roentgen therapy or the radium element pack, is not infrequently followed by long term survival. Such, in brief, are the essential facts on gastric irradiation to the present.

B. RELATION OF INTRAGASTRIC TO EXTERNAL RADIATION THERAPY

It is considerably less difficult to apply radiation treatments to the outside of the body than to the interior of the stomach. Why, then, this present stress on intragastric irradiation?

The chief difficulty with external irradiation by any method, is that of delivering to the stomach tumor itself an adequate dose of radiant energy. No form of external irradiation is capable of delivering to a ventricular tumor over three to six threshold erythema doses of irradiation; and as a rule the tissue dose routinely delivered is more likely to range between 1.4 t.e.d. and 3.2 t.e.d. even after a considerable period of treatment. Adenocarcinomas of any site cannot be sterilized by such hopelessly inadequate doses. For gastric cancers, as for other internal organs, every available skinportal through which the rays must pass becomes damaged long before the theoretically required tumor doses can be reached. For ventric-



High Voltage X-Radiation

Region	Dose to Skin		Dose to Tumor	
	Total r.	T.E.D.	% & Depth	T.E.D.
Stomach Ant.	3000	5.4	35	1.89
" Lat.	3000	5.4	25	1.35
" Post.	3000	5.4	35	1.89
Total Threshold Erythema Doses				5.13

Interstitial Radon Gold Seed

Region	Number of Seed	Total mc.	T.E.D.
Tumor of Cardia	22	30	5
Total T.E.D. to Tumor			10

- Patient H. F. S.

FIG. 23. Cross-section measurement of a patient with gastric cancer, illustrating the computation of the depth dose of radiation. It will be noted that the maximum tumor dosage from high-voltage roentgen therapy, making use of all available portals to the limit of skin tolerance, is five threshold erythemas. The treatment consumes approximately one month of daily exposures and there is unwanted exposure of adjacent vital organs: pancreas, liver, kidneys, adrenals. Compare with effects of endogastric radiation by use of the intracavitary radium applicators discussed in Part II of this monograph. Advantages of combined therapy are obvious.

ular cancers the skin portals available seldom exceed three in number and severe damage to nearby vital organs is difficult to avoid.

Carcinomas of the urinary bladder, for example, require a

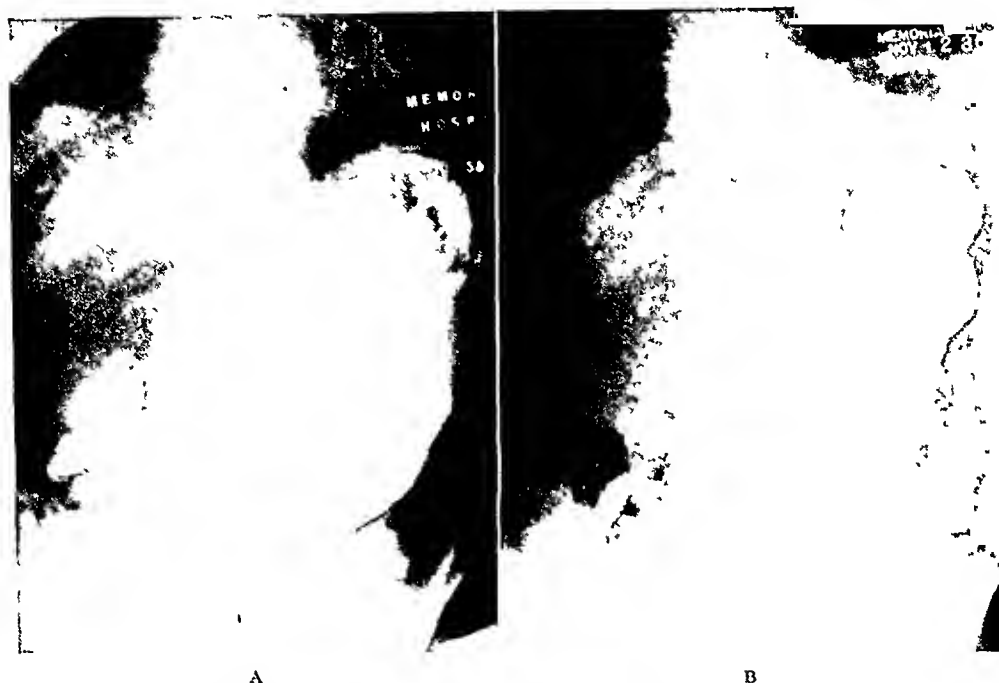


FIG. 24. A, roentgenogram of a bulky fundal tumor (probably lymphosarcoma) prior to external irradiation. B, roentgenogram of stomach after telerradium therapy. All evidence of neoplasm has disappeared. This patient lived four years following irradiation. (An unusual degree of radiosensitivity, for malignant tumors of the stomach, but a response not infrequently observed with lymphosarcomas.)

tissue dose of from 10 to 15 t.e.d. for definitive cure, except in rare instances. Thus Dean writes, "Suggestive clinical data have been collected from the study of a series of patients with proved bladder cancers who have apparently been cured more than five years. . . . Computations showed that the average minimum tissue dose of radiation given these patients was approximately 10 t.e.d. In the author's present practice at least 15 t.e.d. are delivered to all parts of the tumor. And because every patient inadequately treated will die of his disease, 12 t.e.d. will be considered the average successful tissue dose of radiation for the treatment of bladder cancers."²⁵ Cancers of bladder, rectum, uterus and other internal organs cannot be cured by external irradiation alone. What expectation is there, then, for so curing the more deeply situated cancers of the stomach by such methods, unaided by other means?

External radiation for gastric cancers consists of (1) teleradium therapy or the radium element pack, (2) high voltage roentgen therapy (from 200 to 250 k.v. machines), and (3) suprahhigh voltage roentgen therapy (from the 700 to 1,000 k.v. machines). Examples of present routines for external radiation at The Memorial Hospital, serve to display the inadequacy of total tissue dosage delivered. (Figs. 23 and 24.)

EXAMPLE A. TELERADIUM THERAPY

Source of energy, the four gram radium element pack.

Radium-skin distance, 15 cm.

Portals, 44 sq. cm. source.

Number of portals, one to three (anterior (left lateral) posterior)

Filter, 0.35 Pt. plus 1.5 mm. brass.

Fractionation, one port daily in succession.

Total dosage sought, 80,000 to 120,000 milligram hours (80-120 gram hours)

Time for delivery, 2 hours daily for 30-45 days.

Estimated T.E.D. througout the gastric tumor—equal approximately 3, when all treatments are given

EXAMPLE B. HIGH VOLTAGE EXTERNAL ROENTGEN RAYS

Source of energy, 200 k.v. tube rectification.

Distance, 70 cm.

Portals, large rectangular 10 X 12.

Number of portals, one to three (Ant., post., left. lat.)

Filter, 0.5 mm. Cu., plus 1.0 mm. Al.

Fractionation, 250-300 roentgens daily, in succession.

Total dosage, 2,400-3,000 roentgens to each port.

Time for delivery, 3 to 5 weeks of daily treatment.

Estimated T.E.D. to reach the tumor, 3 to 3½.

EXAMPLE C. SUPRAHIGH VOLTAGE ROENTGEN THERAPY

The million volt machine (1,000 k.v.) has not been in use for a sufficiently long period for a standardization of technic. The Memorial Hospital unit has been in operation only since June, 1940. It is evident, however, that this source can add not more than 1 to 3 T.E.D. to a gastric cancer beyond that from the 200 K. V. machine.

The filter is of compound variety and equivalent to 5 mm. of lead.

Three portals (or two portals) of large size are treated from 70 cm. target skin distance.

Doses approaching 3,000 roentgens are sought.

Estimated T.E.D. to reach a gastric tumor, 4-6 in from 3 to 4 weeks of daily treatment.

Studies of suprahared roentgen ray therapy made elsewhere have lead to the conclusion with regard to upper abdominal tumors, "Treatment has not been well tolerated by the patient, and results have not been reassuring."²⁶ Undue exposure of vital structures adjacent to stomach (liver, pancreas, adrenals, vessels) is a serious problem.

These specific examples reveal why no form of external radiation can deliver tissue doses to a gastric tumor adequate for more than palliative effects. On what basis could a final conclusion be reached that gastric cancers are exceptionally radioresistant or are unsuited to radiation therapy, when total depth doses thus far delivered have been but a fraction of those used for definitive cures of adenocarcinomas in other viscera? Is it not obvious that all *conclusions drawn thus far relate only to dosages now routinely administered?* There could be no reliable conclusions about dosages which have *not* been delivered. Is it not, then, equally obvious that the present evaluation of gastric irradiation may require complete revision once technical means have been devised for delivering to gastric tumors the doses that correspond more nearly with those known to be theoretically requisite? *Since unaided external radiation is not adequate to furnish a suitable number of threshold erythema doses for gastric carcinomas, adjuvant intracavitary therapy becomes a prime necessity if definitive cures are to be obtained.*

C. AIMS OF INTRAGASTRIC IRRADIATION

The foregoing considerations allow the basic aims of intracavitary radiation to be tersely stated; namely, to facilitate a routine delivery, when desired, of far greater tissue doses of radiant energy than now furnished by external irradiation alone. The technics selected should cause minimal discomfort to the patient and permit suitable flexibility in the fractionation of the total dose delivered.

Yet radiation therapy for gastric cancers entails the overcoming of numerous other serious drawbacks, peculiar to the stomach.

1. *The Motility Factor:* The stomach is a highly motile organ, hence it is not easy to be certain of the exact focus of the external radiation beam.

2. *The Obstruction Factor:* Many tumors obstruct the gastric inlet or outlet. In this circumstance patients will die of starvation or dehydration in a period of weeks or days unless the obstruction is relieved. At The Memorial Hospital the average duration of life from hospital admission to

death was only 1.8 months for untreated patients. At the New York City Cancer Institute the life duration was 2.2 months.

3. *The Infection Factor:* Frequently gastric cancers are so infected as to interfere seriously with the radiation response.

4. *The Adjacent Organ Factor:* The stomach is in such close proximity to pancreas, liver, spleen and adrenals and some of these vital organs are routinely irradiated by external therapy.

5. *The Peritonitis Factor:* This organ is a hollow viscus wherein sloughing or perforation mean peritonitis and death. Fistulas which might be tolerated in the rectum, vagina or bladder prove fatal at this site.

6. *The Vascularity Factor:* The stomach is highly vascular so that multiple implantations and needle punctures are dangerous from the standpoint of hemorrhage. Furthermore, implanted seeds are readily dislodged by the functioning musculature.

7. *The Inaccessibility Factor:* This organ is accessible only by laparotomy with the risk of life entailed; and the organ cannot be repeatedly exposed with impunity.

8. *The Advanced Disease Factor:* Metastatic disease is present with nearly half of gastric cancers even when diagnosed; making local therapy devoid of hope of cure even if locally successful.

9. *The Cachexia Factor:* Because of late disease and gastric obstructions so often present only a minority of patients can withstand the rigors of a twenty to forty day period of daily treatment.

10. *The Nutritional Factor:* The stomach is an organ daily necessary for nutritional requirements; the organ cannot be kept long functionally quiescent by interference from massive radiation.

Successful intracavitary radiation, therefore, must deal with far more than the major problem of adequate tissue dosage; it must also provide for maintenance of nutrition, protection of neighboring vital organs, avoidance of necrosis, perforation or hemorrhage; yield relief of obstructions to gastric inlet or outlet, provide for motility difficulties, etc.—which is indeed a large aggregate order that demands both persistence and ingenuity.

D. CLASSIFICATION OF INTRACAVITARY APPLICATORS

Endogastric methods and applicators now in use should be re-examined to ascertain the degree to which they meet the several desiderata outlined. Intraluminary applicators may be classified according to:

- A. Mode of Introduction
- B. Modality for Which Designed
- C. Physical Appearance and Construction

Classification by Mode of Introduction

1. Oral instruments
2. Gastrostomy instruments
3. Laparotomy instruments

Classification by Function or Modality

1. Radium applicators
2. Radon applicators
3. Roentgen ray applicators
4. Electrosurgical applicators

Classification by Appearance or Construction

1. Trochar needles
2. Bougies
3. Sounds
4. Catheters
5. x-ray tubes
6. Electrodes
7. Multiple-lumened tubes and endogastric balloons

The Oral Instruments. No record was encountered in medical literature of attempts to treat gastric neoplasms by way of the mouth. This excepts, of course, the use of intraesophageal radium element tandems which are often passed as far as the gastric inlet. The multiple-lumened gastrointestinal tubes and endogastric balloons presented in the final headings of this paper and now in routine use on the gastric service of The Memorial Hospital have not been previously described. In fact, the search of the Index Medicus already mentioned discloses that no oral instruments of any kind are used in the treatment of stomach cancers, so that if any such have ever before been proposed they are now either obsolete or remain unheralded.

The Gastroscopic Instruments. (a) *Trochar Needles.* Endogastric treatments through fistulous tracts have consisted for the most part in the use of trochar needles. The gastrostomy stoma is dilated with Hegar cervical dilators and a small esophagoscope or cystoscope is passed to the interior of the stomach. The adjacent skin is incised under novocain, if necessary. The stomach is now inflated, the tumor visualized, and the seeds introduced under direct vision, using long, hollow, implantation needles. By such means a few capillary gold radon seeds, usually two to four, may be implanted at a sitting. However, the entire tumor is not visible at one time. (Fig. 25.) This limitation in vision, dangers of perforation and hemorrhage, and difficulties

in the proper spacing of seeds, sharply limit the utility of the method. To implant seeds evenly throughout the usual types of stomach cancer by this route is virtually out of the question with present

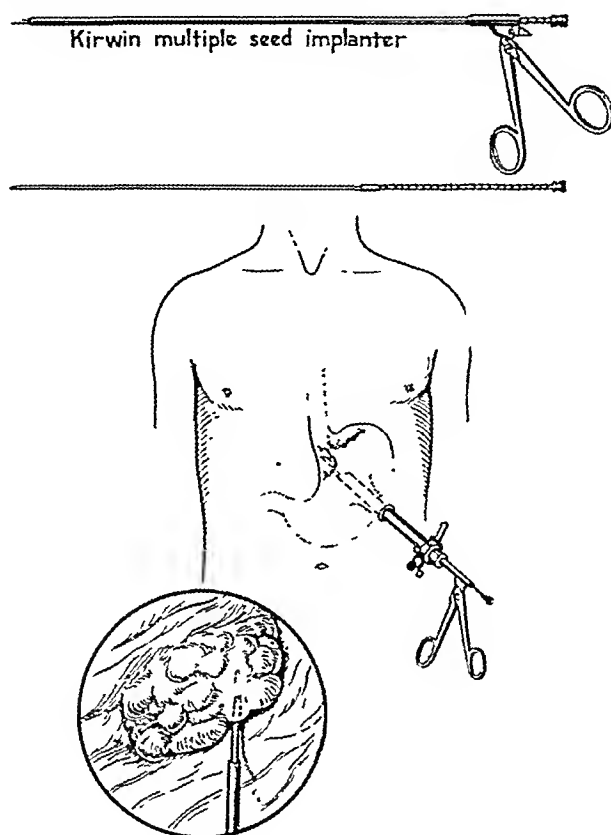


FIG. 25. Interstitial deposition of gold radon seeds in a cancer of the gastric cardia. The treatment is accomplished under direct vision by means of the anterior gastroscope and the Kirwin multiple seed implanter, used through a Janeway gastrostomy.

equipment. (b) *Radium Sounds*. The initial introduction of radium sounds through a fistulous tract by Wickham and DeGrafs (1914) has been cited. Why more use has not been made of this method is problematical, but it is likely that difficulty in an accurate placement of applicators has been the chief drawback. Isolated reports of single patients treated comprise the only records for this therapy. (c) *Electrical Applicators*. Strauss et al., of Chicago, created considerable interest in their recent report on endogastric electrosurgery and the now famous "gastric zipper operation." Secondary reports have

not been published and end results are not available. We have had no experience with this procedure at The Memorial Hospital. (Fig. 26.)

The Laparotomy Instruments. These consist of trochar needles,

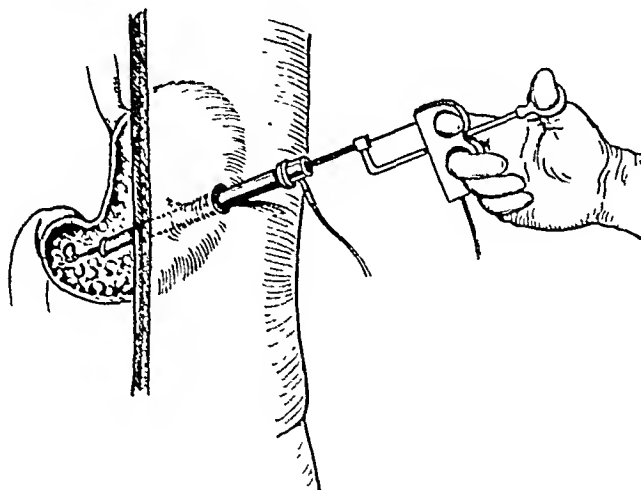


FIG. 26.—Endotherm excision (cutting snare) of multiple gastric polyps. Instrumentation performed under direct vision through a retrograde gastroscope.

radium sounds, and special x-ray tubes. The first radon capsules employed were bare glass cylinders (Levin, 1922). In 1927, glass capsules were inserted into a prepyloric cancer at time of gastroenterostomy on The Third Surgical Division of Bellevue Hospital; three weeks later a resection of the tumor and contained capsules was performed. This patient was followed for more than three years and was free of evidence of disease when lost to follow-up inquiries; but it is probable that the resection rather than the interstitial therapy accounted for the longevity. At The New York City Cancer Institute one of the authors, in four surgical explorations, implanted gold radon seeds varying in strength from 0.75 mc. to 3.0 mc. into the circumference of obstructing cancers of the gastric cardia, using the transmucosal route. Improved swallowing and symptomatic gains were observed but all the patients died within a year and one-half. Kaplan reported but three instances of interstitial irradiation of stomach tumors up to the year 1935 at this large Metropolitan cancer center.²⁷ From The Memorial Hospital fifteen similar treatments, the first in 1931, have been recorded implanting the gold radon seeds sometimes through the peritoneal surface and sometimes through the mucosa (Pack). Survivors at six months after such treatment were 32 per cent. When external irradiation was added to the in-

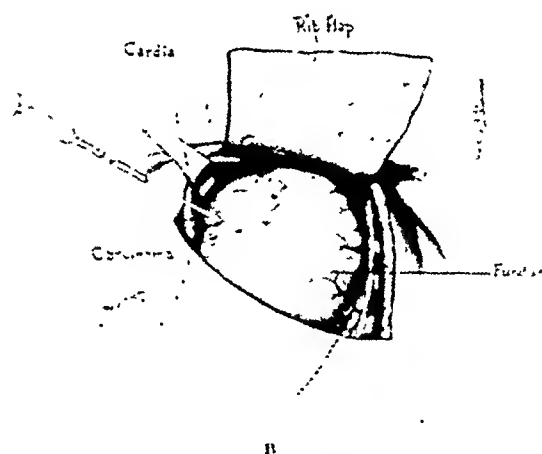
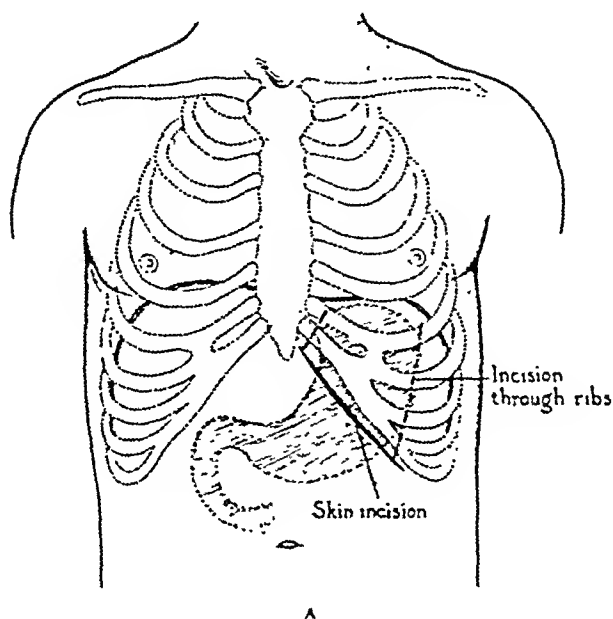


FIG. 27. A, diagram of Marwedel's incision below the costal margin and the Baudet and Navarro technic of elevation of the rib flap to expose the cardia. B, a drawing to show retraction of the superficial tissues upward, with elevation of the costochondral flap to expose the cardia. Interstitial irradiation is carried out by oblique insertion of gold radon seeds into the tumor.

terstitial therapy the six month survivals were 52 per cent; but complete tumor regression was not observed and all patients died of the disease in less than two years.

Difficulties in implanting radon gold seeds throughout a gastric neoplasm must be experienced to be appreciated. Parts of the tumor as a rule are overtreated while others remain inadequately treated, hence, complete tumor regression could scarcely be anticipated. In practice it has never been attained for a cancer of this site. The trauma inflicted by multiple needle punctures, the violation of principles of surgical asepsis inherent in use of a transmucosal approach, danger of disseminating cancer cells by way of the many opened lymphatic channels, and fear of late wall necrosis and perforation restrict intramural therapy to application for highly selected cases. Nevertheless certain patients so treated have obtained remarkable tumor regression disclosing the true potentialities of local irradiation and arguing strongly against its total discard. The Baudet-Navarro costal flap incision for exposure of the gastric cardia is shown in an accompanying illustration. (Fig. 27.)

E. GASTROTOMY AND "CONTACT" ROENTGEN THERAPY

A form of treatment quite the opposite of suprahigh voltage roentgen-ray therapy is found in so-called Chaoul therapy or the "contact" use of low voltage x-rays. This was first employed for gastric tumors by Pack at The Memorial Hospital in 1939. Figure 3 shows the operative technic involved. Here roentgen rays are delivered to the open stomach by holding an air-cooled x-ray anode directly against the tumor or at a target tumor distance up to 2 cm. The outfit consists of a portable cabinet which can be rolled about the operating room. Within the cabinet are a transformer, a condenser and an air blower. The machine can be connected with any 110 volt alternating current outlet plug. The x-ray tube is held by the surgeon or his assistant; or it may be secured in place by a fixation stand. The roentgen outfit at 50 k.v. and 2 ma. varies from 550 r. to over 7,000 r. per minute depending on filter and distance. To the intrinsic filtration of 0.2 mm. Al. may be added sterilizable discs to give a total filtration of 2.5 mm. Al. To treat a stomach cancer with a surface measuring 6 by 8 cm. it would require a little more than half an hour (36 minutes) of operating time to deliver 4,000 r. evenly over the surface through these multiple 2 cm. ports using 1 cm. target distance and 1 mm. Al. filtration. (Figs. 28 and 29.)

A feature of contact x-irradiation is the high degree of protection afforded neighboring organs. This is ensured by a sharp gradient in depth doses delivered. Using the factors above enumerated, only

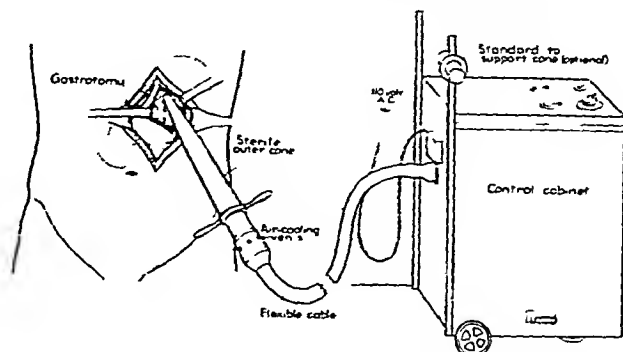


FIG. 28. Intracavitary roentgen therapy of a gastric cancer. Diagrammatic view of Philips' tube inserted through a gastrostomy.

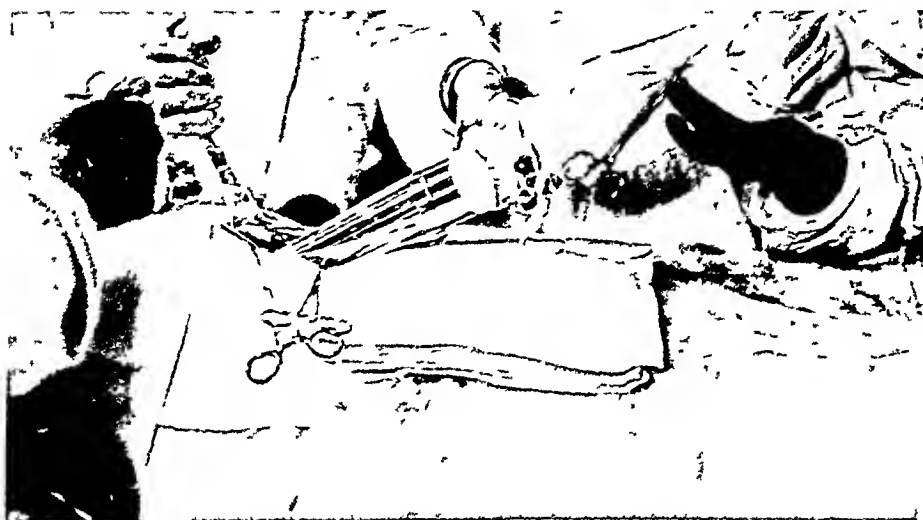


FIG. 29.—“Contact” roentgen ray therapy for cancer of the stomach. The air-cooled x-ray anode of the Philips' machine is inserted into open stomach at time of laparotomy.

22 per cent of the dose at the tumor surface is delivered at 1 cm. below the surface. One handicap in the use of present equipment is the exposure of the operating crew to scattered irradiations which are plentiful. Another, is the extremely superficial nature of this treatment. The tumor surface could readily be necrotized before a cancericidal dose was given at a depth of 2 cm. It would be little less than folly to anticipate curative results by single surface exposures

of this type administered to bulky gastric cancers at the time of operation. Perhaps in the future larger gastrostomy openings can be made (Beck-Jianu variety) to allow repeated use of low voltage anodes as employed through cystostomy wounds for bladder cancers or for exteriorized cancers of the rectum. But at present Chaoul therapy for ventricular tumors is decidedly experimental.

F. CONCLUSIONS ON GASTRIC IRRADIATION

Summarily, it is found that intragastric radiation therapy, to the present, by whatsoever technics applied, has been desulatory and sporadic. End results have been provocative and stimulating and have disclosed remarkable palliation in isolated cases, but have proved distinctly disappointing in terms of total tumor regression and of definitive cures. Published reports only serve to illuminate the essentially unconquered nature of inherent problems. No method of external irradiation, of intracavitary irradiation, or of allied internal and external irradiation is yet capable of administering as many as 10 t.e.d. throughout a gastric cancer except in those rare instances in which extensive external therapy has been combined with interstitial gold seed implantations for tumors of unusually small size and favorable location.

Two facts sum up as quickly as could well be done the net result and meaning of intracavitary methods thus far. *Fact One:* From no author and no institution have reports yet emanated of as many as a score of treatments by any endogastric method. *Fact Two:* No single patient with a pathologically proven epithelial malignant neoplasm of the stomach treated by endocavitary radiation therapy, external radiation therapy, or by combined external and intracavitary radiation therapy, without gastrectomy, has survived treatment for a period of three years.

2. BALLOON APPLICATORS FOR INTRACAVITARY IRRADIATION

The remainder of this communication will deal with a totally new and hitherto undescribed method of radiation treatment for ventricular tumors. This technic is so easily applied, so flexible as to fractionation of doses, so devoid of overirradiation of neighboring vital organs, and is so free from dangers of perforation, hemorrhage, or interference with regular food intake, yet is so capable, also, of delivering throughout the tumor any number of threshold erythema doses of radiant energy selected, as to constitute a definitely new departure in gastric irradiation.

The radium applicators described prove capable of delivering in a single treatment as many threshold erythema doses to all parts of the tumor as can now be given by any form of external irradiation in a period of from fifteen to thirty days of uninterrupted daily treatment.

It would be difficult to overstate the practical significance of equipment of such potentialities. So far as the administration of radiant energy to the intrinsic stomach cancer is concerned, these applicators with their relatively small radon content represent, in essence, the equivalent of furnishing at once for every hospital to employ this technic, a 4 gram radium element pack or a million volt roentgen ray machine—an energy-equivalent of considerable moment. Yet treatment of this type conflicts in no way with present equipment, for it can be utilized in conjunction with external irradiation in numerous patterns of allied therapy.

In addition, *the methods to be described should bring within the fold of radiation therapy immense numbers of patients of a type heretofore treated by radiation methods in but rare instances only.* Stomach cancers, it should be recalled, constitute about 25 per cent of all cancers; and it now appears probable that ventricular tumors soon will become of much practical importance to radiation therapists generally. The multiple-lumened gastrointestinal applicators depicted can be used by any physician who is capable of handling radium and well versed in the basic laws of radiation physics.

But of still more significance: *With this equipment, as discussed under the heading, Dosimetry, it now for the first time becomes physically possible routinely to carry the total tissue doses of irradiation for stomach cancer to any level desired.* Radiation therapy thus reaches

a point where the gamma roentgen units or threshold erythema doses administered may, when elected, be made fully equal to those known to be required for the control or destruction of carcinomas of other internal organs.

The degree, however, to which patients can tolerate cancericidal doses at this site, the most advantageous fractions in which to administer the total dosage, and ultimate end results in terms of complete tumor regression or definitive cures, if any, must await future determination by cautious and prolonged clinical applications.

A. DESCRIPTION OF THE FIVE-WAY APPLICATOR

The multiple-lumened gastrointestinal applicator shown in Figure 1 was devised by one of the authors (E. M. L.) and consists of a quintet of passages which extend from the body surface into the stomach or beyond. The individual lumens subserve the following functions: (Fig. 30.)

Passage One. The Radium Channel. For passing radium or radon into the interior of the stomach.

Passage Two. An Inflation Channel. For inflating a distensible endogastric bag or balloon to lie within the pyloric antrum.

Passage Three. A Second Inflation Channel. For distending a second intracavitary balloon which will occupy the region of the fundus. The purpose of these balloons is to facilitate distance irradiation by separating stomach wall and radium core by a controlled number of centimeters.

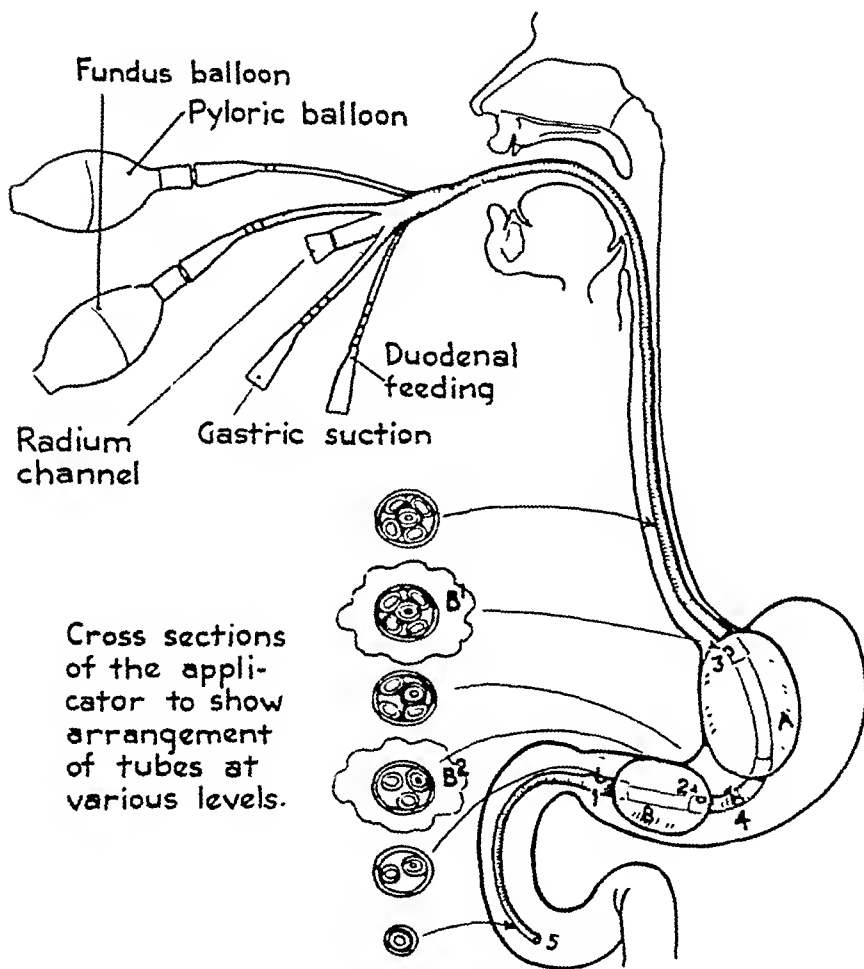
Passage Four. A Suction Channel. For intermittent or continuous suction, to empty the organ of its contained fluids, gas or mucus.

Passage Five. The Feeding Channel. For introducing food into the duodenum while the applicator is in use.

It can readily be seen that as these intracavitary balloons are inflated by passing air through passages two and three, the Magenblase or gastric air-bubble is automatically expelled by way of passage four. The Magenblase is thus, in a sense, transferred to the interior of the fundic balloon. Through this instrument (a) irradiation of the cancer, (b) inflation of the fundus or the pyloric balloon, (c), or both, (d) gastric emptying and (e) duodenal feeding, can simultaneously be attained.

The individual channels vary slightly in width but the diameter of each is approximately No. 8 French, except for the radium channel which is of No. 14 French diameter. The fundus balloon is

6 cm. long, and the length of the pyloric balloon is 4 cm. The total thickness of this oval five-lumened applicator is 6 by 8 mm. Such a small over-all diameter allows the unit to remain in situ for any



A = Fundus balloon B = Pyloric balloon
 1 = Radium channel 2 = Airway to pyloric balloon
 3 = Airway to fundus balloon 4 = Gastric
 suction channel 5 = Duodenal feeding channel
 (Rings on tubes of hydra-head correspond
 to numbers)

FIG. 30. The Livingston multiple-lumened radium applicator for the intracavitary treatment of cancer of the stomach.

selected number of hours or days with minimal discomfort to the patient. Cross-sections of the applicator at various levels from the

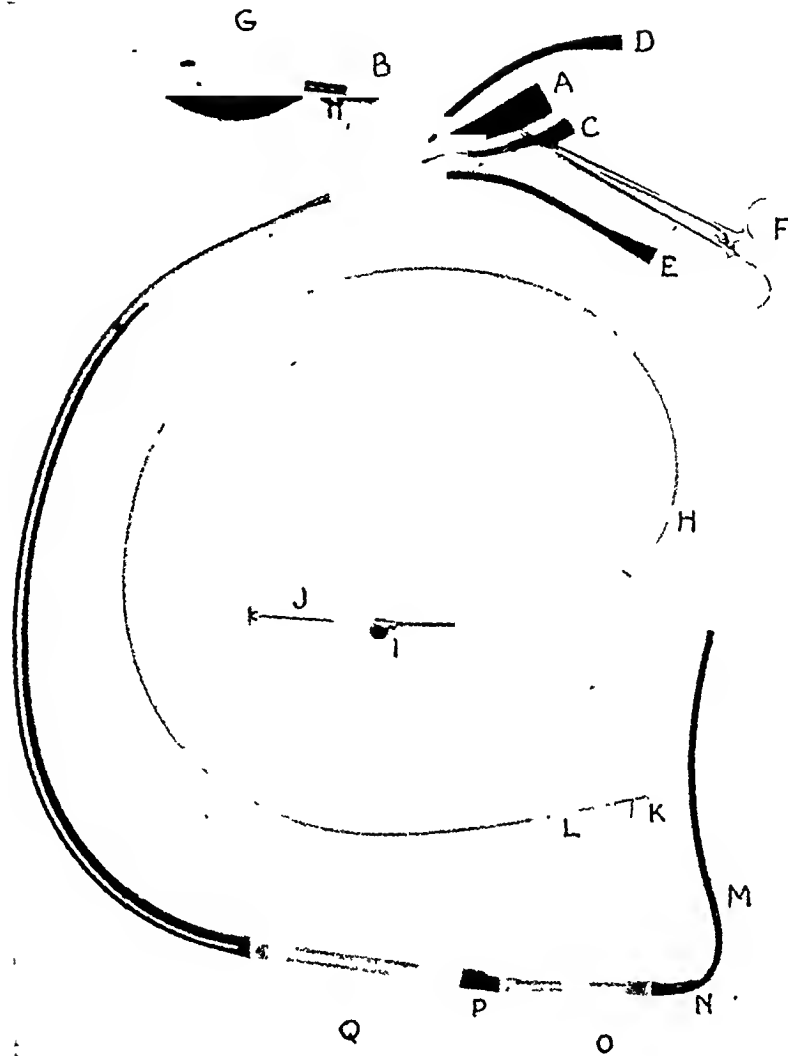


FIG. 31. Details of construction of the multiple lumened radium applicator for the intracavitary treatment of cancer of the stomach. A, radium channel; B, inflation channel for pyloric balloon; C, inflation channel for the fundic balloon; D, gastric suction channel; E, duodenal feeding channel; F, clamp closing an air-way; G, inflation bulb attached to an air-way; H, the flexible radium core; I, set-screw for stylet; J, the stylet or ejector; K, detachable tip for loading the radium or radon capillary tube; L, site for storage of radioactive tube; M, duodenal feeding tube; N, terminal opening of radium channel; O, pyloric balloon; P, gastric suction opening; Q, fundus balloon.

upper dental arch reveal the number and arrangement of the channels at specific levels. The total length of the applicator from tip of hydrahead to the end of the duodenal feeding tube is approxi-

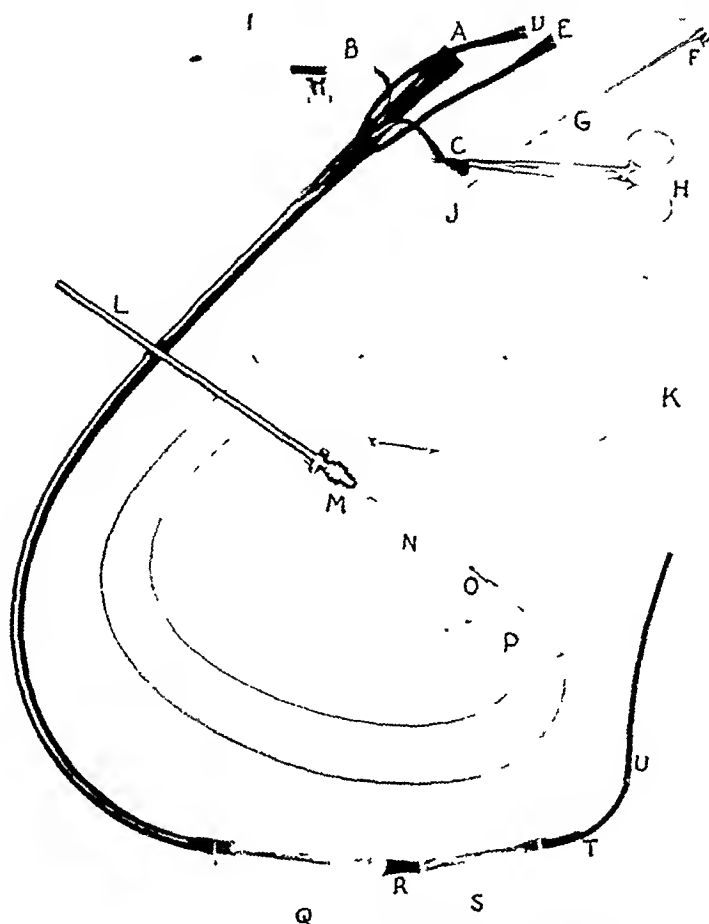


FIG. 32. Details of construction of flexible radium core and endogastric radium applicator. A, D, C, D, E, as in Figure 31. F, re-enforced tip of ejector stylet; G, detachable tip of the flexible radium core; H, clamp on air-way; I, inflation bulb on an air-way; J, flexible radium core; K, the stylet or tube ejector; L, safety locking device, V, detachable loading tip; N, the capillary radium or radon tube; O, nest for radium tube; P, tip of stylet; Q, fundus balloon; R, suction opening; S, pyloric balloon; T, radium channel opening; U, the duodenal feeding tube.

mately 80 cm. A diagram discloses at a glance the precise length of each individual passageway. These complex rubber applicators are at present manufactured by the Davol Rubber Company of Providence, Rhode Island. (Figs. 31 and 32.)

B. OUTSIDE EQUIPMENT

The channels of this multiple-lumened unit are connected on the outside of the body, respectively, with a feeding receptacle (lumen five), a negative pressure pump or hydraulic suction outfit to provide for gastric emptying (lumen four), and two pressure manometers to furnish visual evidence of the constant inflation of the fundic and pyloric balloons (lumens two, and three). The hydrahead of the applicator is held in place by a head band or may be taped to the patient's cheek. For the assembly of outside equipment a metal table and portable stand, similar to that used by an anesthetist or a nose and throat specialist, can be employed, but such elaborate carriages are not necessary.

C. TWO-, THREE- AND FOUR-WAY APPLICATORS

In addition to the applicators with five channels, others with a lesser number of lumens have been designed. Each has its special modifications and purpose. The two-lumened unit, for example, is little more than an elongation of the well known prostatic hemostasis bag. (Fig. 33.) This simple applicator is employed in treating cancers of the cardiac end of the stomach and terminal esophagus. No provision is here made for gastric emptying or duodenal feeding, and these units are used for treatments of relatively short duration. The distance from the upper dental arch to the proximal end of the endogastric balloon in this unit is 45 cm., while the length of the bag is 5 cm. The radium passageway, or channel one, is the same in all applicators. Through this the radioactive tubes or capsules are passed into or withdrawn from the stomach in a metal core or other suitable inserting device. The most satisfactory radium housing to the present has been a core of spring-steel tubing similar to that used for implanting radon seeds into the urinary bladder. The suggestion for the adaption of such tubing for endogastric balloon therapy was jointly made by Dr. James Duffy of The Memorial Hospital attending staff and Dr. William McCarthy of the resident staff, to replace previous less efficient methods of radon insertion. A metal set-screw at the oral end of this core controls the position of a central stylet for ejecting the radon capsule after use; and a threaded cap at the gastric end of the core is the site for loading the radioactive agent. Several improvements have been made in this metal core by Mr. Frederick Wappler of the American Cystoscope Company.

D. LOADING THE APPLICATORS

These applicators are delivered to the clinician in lead containers provided by the physics or radiation therapy department. The



FIG. 33. The bi-lumened intragastric radium applicator for the treatment of carcinomas of the cardia and gastric fundus.

prescribed radium or radon is already in place. The sole duty of the therapist is to adjust the position of the radium core within the radium channel or balloon encircled passageway. This spacing is arranged to fit the requirements for the individual tumor treated.

Questions with regard to the alignment of the radioactive capsule and the amounts of radium to prescribe are dealt with in headings to follow.

E. TECHNIC FOR INTRACAVITARY INSERTION

Applicators are introduced by the oral route or may be applied in retrograde fashion through a gastrostomy stoma. The technic for gastrostomy insertion is as follows: The patient first swallows a heavy silk thread attached to a BB shot, taken at a rate of 1 foot an hour for three hours. The gastrostomy stoma is now dilated with graduated Hegar cervical dilators and an 8 mm. endoscopic tube is passed into the stomach. The viscus is aspirated, then inflated, and the cord is picked up with forceps and drawn to the body surface. Here it is tied to a stout shoemaker's twine, attached, in turn, to the tip of the radium applicator. The unit is now drawn into position. As soon as the stomach has been entered the endogastric balloon is inflated. This distal inflated balloon is then drawn to firm anchorage against the gastric cardia by traction on the oral end of the leader cord.

Oral insertion requires scant description. This rubber tube is swallowed exactly as is any medium calibre stomach tube. With disease at the cardia there may be a period of delay at this point. Passage may be aided by gentle manipulation if needed. The incisor teeth mark on the applicator discloses when introduction is complete. Now predetermined amounts of air are pumped into the endogastric balloons. Exact amounts will depend on the inflation tool used and the balloon diameters desired. Inflation tests must be made just prior to the insertion to acquire this information. Once introduction has been completed a slight upward traction at the oral end of the applicator will pull the fundus balloon into firm anchorage against the gastric cardia. Duodenal feeding or a continuous fluid infusion may commence at once. Where desired these endogastric applicators may be inserted through the nares.

F. CLINICAL APPLICATIONS OF RADIUM DOSIMETRY

This complicated and significant topic must be discussed elsewhere. The purpose of the present communication is to describe equipment and rationale rather than to furnish details on radiation requirements. But a few statements may be included at this point, and a chart made from data furnished through the kindness of

Dr. Edith Quimby illustrates specific tissue doses delivered in a typical case. (Fig. 34.)
The Memorial Hospital routine at this time is to utilize a

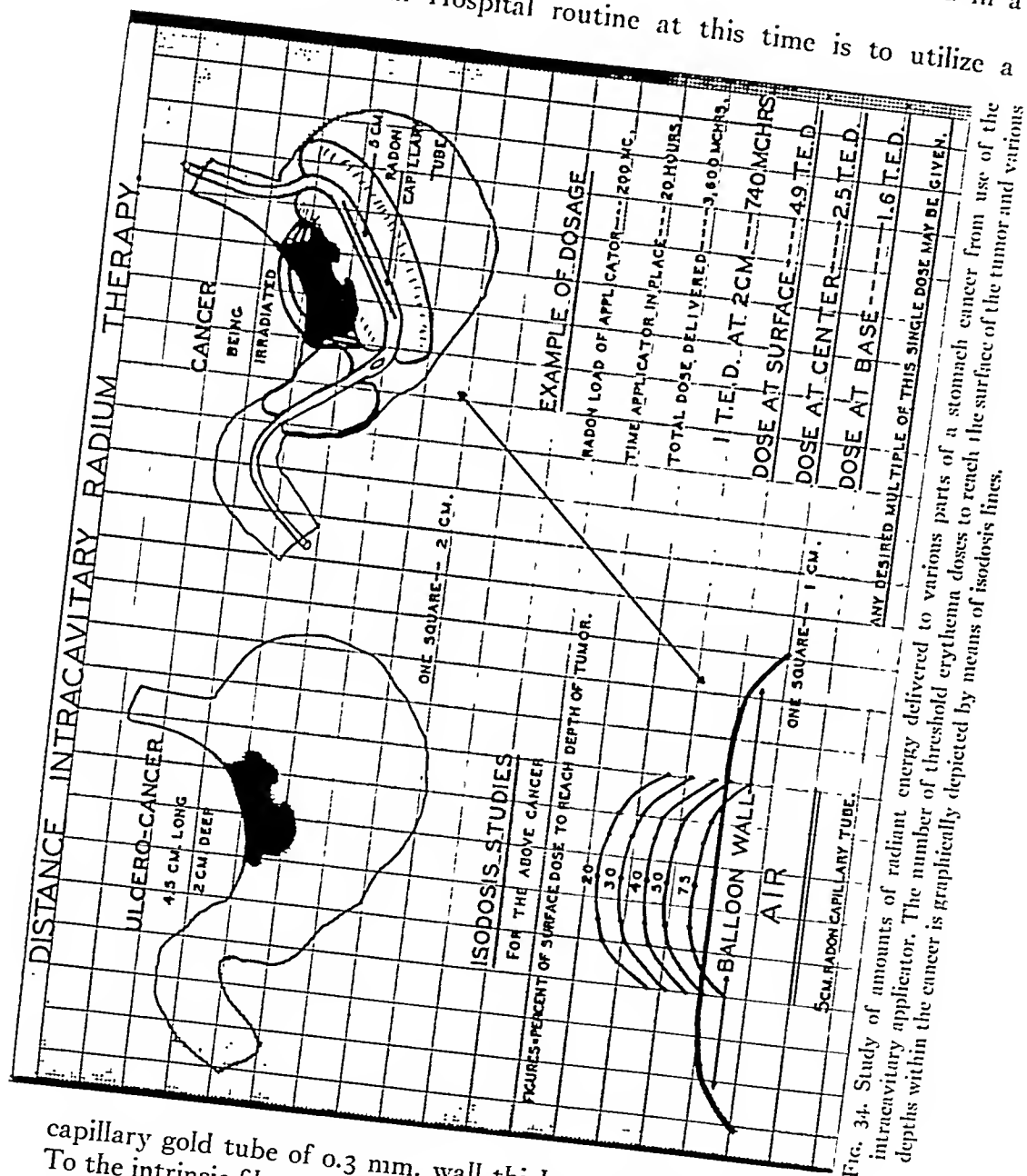


FIG. 34. Study of amounts of radiant energy delivered to various parts of a stomach cancer from use of the intracavitary applicator. The number of threshold erythema doses to reach the surface of the tumor and various depths within the cancer is graphically depicted by means of isodose lines.

capillary gold tube of 0.3 mm. wall thickness and 5 cm. in length. To the intrinsic filter of this tube must be added that of the metallic inserting core when this type of introducer is employed. The radon

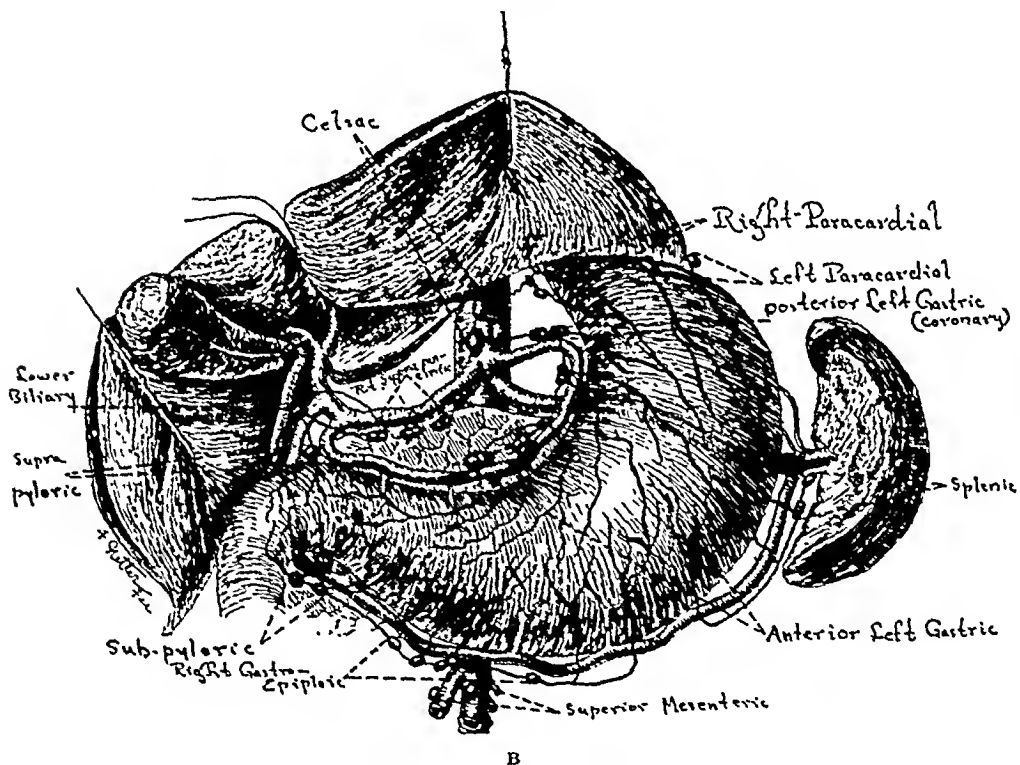
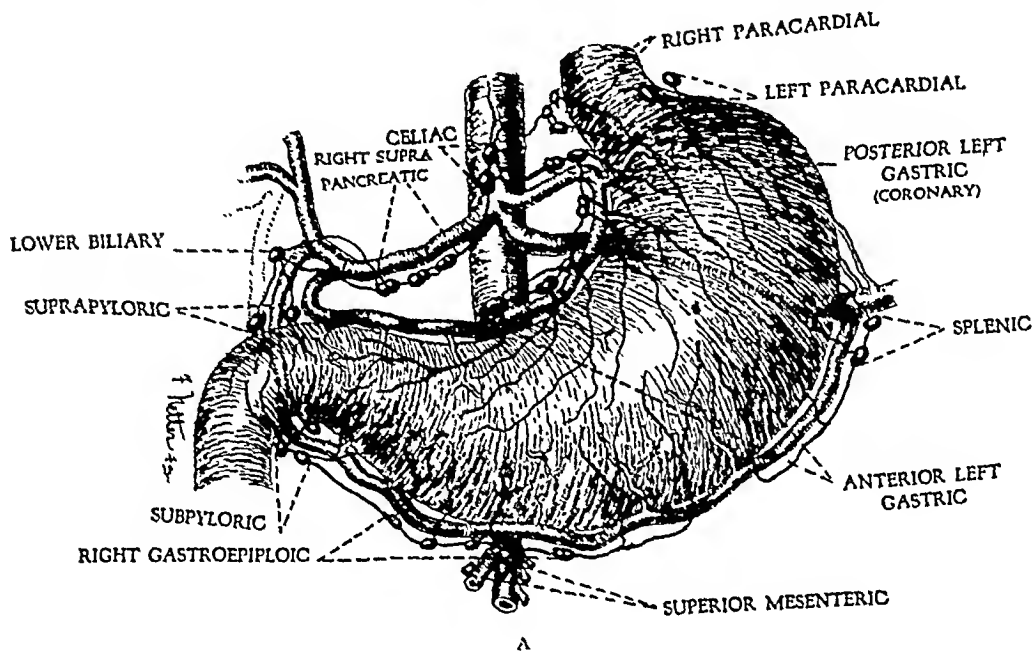


FIG. 35A and B. Effect of intragastric radiation therapy on the juxtagastric lymphnodes. Comparing this picture with the chart of Figure 34 shows the effect of intragastric "distance irradiation" on the lymphnodes immediately adjacent to the gastric walls. (From Livingston's "Clinical Study of the Abdominal Cavity and Peritoneum." New York, 1934. Paul B. Hoeber.)

content of the tubes usually varies between 150 mcs. and 200 mcs. A weaker tube load will alter the effects and call for more prolonged periods of treatment. At the initial treatment, when palliation only is sought, from 500 to 1,000 millicurie hours are administered. This is followed by additional applications of 500 or more millicurie hours at weekly or bi-weekly intervals, reconsidering dosage in terms of results secured and changes observed through the gastroscope. With the factors stated it requires only two and one-half to three hours to deliver 500 millicurie hours. The time required for 1,000 millicurie hours is from six to eight hours, depending on the exact applicator load. From this base other dosages may be computed, or they may be ascertained from tables on rates of radon decay.²⁸ In clinical practice we have at times given 2,000 millicurie hours or more at the initial treatment. The dose received by various parts of the tumor naturally varies with the balloon diameters and size and shape of the tumor under treatment, as later discussed. (Fig. 35.)

When theoretically curative total tissue doses are to be delivered, in suitable cases, the radiant energy to the depths of the cancer should be carried to eight to ten threshold erythema doses, if tolerated. The feasibility of delivering such cancericidal doses and questions relative to spacial arrangement and fractionation of doses are now under test and will be the subject of later reports.

G. INTRACAVITARY ALIGNMENT OF BALLOON APPLICATORS

A query of prime importance often raised is "How may one be certain concerning the relation of the line-source of radiant energy and the particular tumor under treatment?" On the answer rests the estimates of the radiation physicist.

One or more of five methods are employed: The radium core can be aligned with the cancer; first, by measurements taken from roentgenograms; second, from observations of the gastric interior and tumor through the gastroscope; third, from fluoroscopic studies, (this is the method of choice and the present practice is to verify balloon positions by fluoroscopy in every case, aiding placement, if necessary, by external manipulation); fourth, by the use of an anterior gastroscope or televentroscope, an instrument that offers a perfect means for verifying balloon positions, but necessitates the presence of a gastric fistulous tract; fifth, and last, from caliper measurements taken at the time of exploratory laparotomy.

The point for emphasis is that of placing the radioactive core at a proper distance or alignment along the radium channel within the applicator. This core, being semirigid and of known length, the

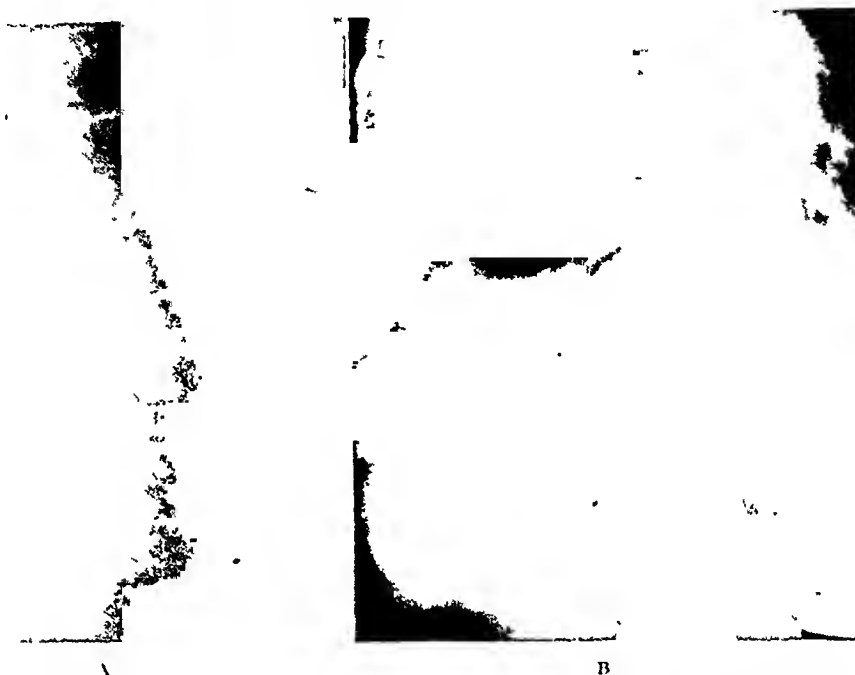
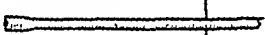


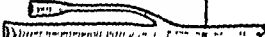




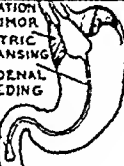


FIG. 36. Alignment of intracavitary radium applicators. A, the single balloon applicator in situ for treatment of cancer of the gastric cardia. B, the multiple balloon applicator in situ for treating a cancer of the body of the stomach or pyloric antrum.

position of the 5 cm. radon capsule is always under full control. Every centimeter of movement at the oral end of the core signifies a corresponding centimeter of movement within the applicator channel and at a known distance from the incisor teeth mark or gastric cardia within the system of distended balloons. Thus the position of the radium core is surprisingly exact. This is in marked contrast to the relatively uncertain focus of the radiant beam when external radiation therapy is used. It should be recalled that the stomach wall is normally collapsed within the peritoneal cavity, with anterior and posterior walls in apposition, save in the presence of fluid, food, air or neoplasm. The radium-applicator balloons fill the entire space along the Magenstrasse as shown in the models, hugged snugly in position by the contracted stomach musculature. They come to lie in the long axis of the organ and at right angles to the surface of the tumor. Hence, correct alignment is secured with relative ease in the average case for a cancer of any part of the organ; and seldom do pathological variations present insurmountable

Endogastric Radiation Therapy

Mouth end	Esophageal tube	Gastric radiation	Gastric cleansing	Duodenal feeding	Application
Single action unit 		 Radium nests	No provision	No provision	 RADIATION OF TUMOR
Double action unit 		 Radium nests		No provision	 RADIATION OF TUMOR GASTRIC CLEANSING
Triple action unit 		 One-way valve for emptying stomach	Intake	Output Duodenal bucket for feeding	 RADIATION OF TUMOR GASTRIC CLEANSING DUODENAL FEEDING

Details of three layer treatment balloon-

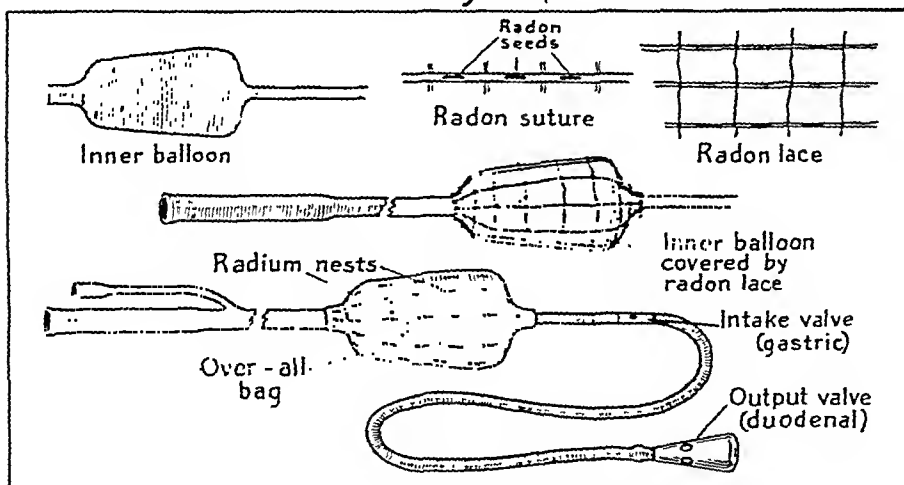


FIG. 37. Intracavitary "contact" radium therapy, using gold radon seeds. This form of intracavitary therapy has a limited value because of the superficial nature of the radiation effect. The gold radon seeds are placed in equidistant nests within a special silk suture, secured to the outer surface of the balloon.

difficulties, despite the fact that single balloons tend first to lodge within the gastric fundus. (Fig. 36.) External manipulation of the balloons through the abdominal wall may be effected under the fluoroscope.

II. "CONTACT" RADIUM THERAPY FOR GASTRIC CANCER

At the outset of these studies in 1937 use was made of a special radon suture devised by Dr. Fred Hames now of Pine Bluff, Arkan-

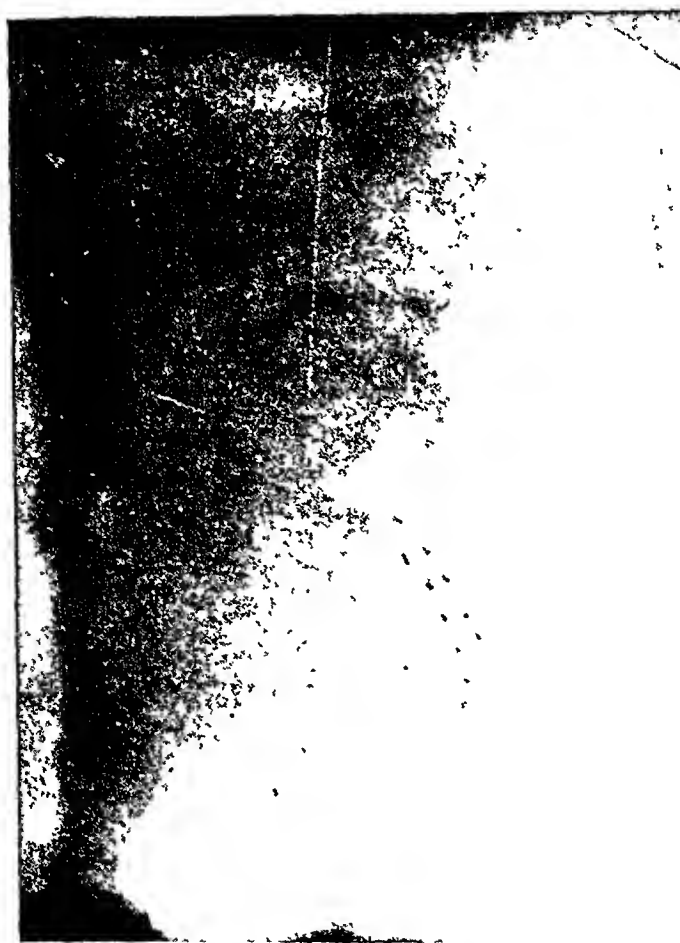


FIG. 38. Roentgenogram showing the even spacing of the gold radon seeds lodged within the Hames'-Deknatel radium suture and attached to the outer surface of an intracavitary balloon.

sas, together with the J. A. Deknatel Company of New York. It is a pleasure at this time to pay tribute to the early co-operation accorded us by Dr. Hames. The Hames' suture is a woven silk thread provided with equidistant and mechanically produced nests for insertion of removable gold radon seeds. (Fig. 37.) This insures machine-

governed precision in seed alignments. During the initial endogastric treatments sutures of this type were attached to the outer surface of intraluminary balloons, then covered in turn by secondary and

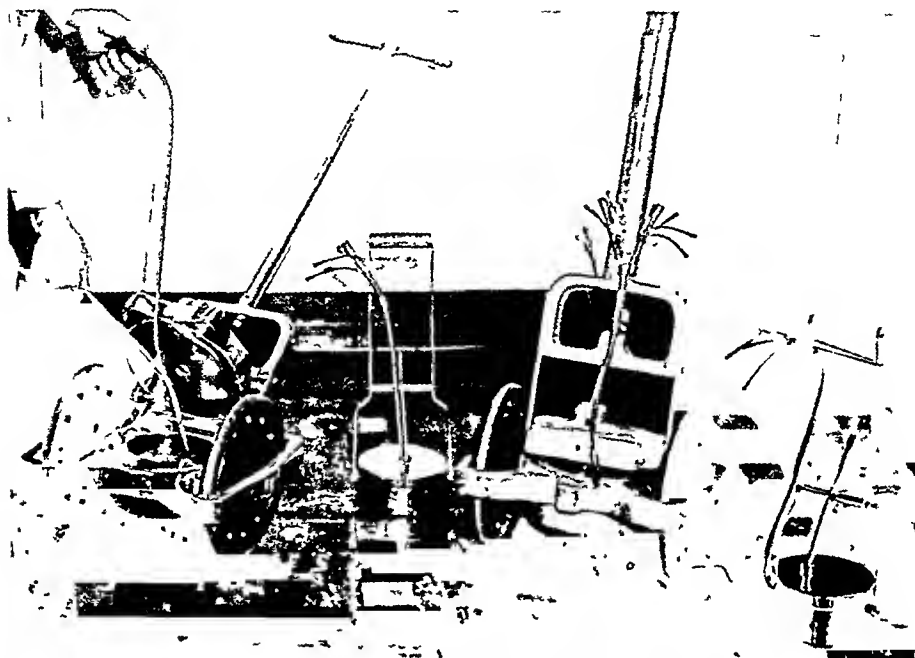


FIG. 39.—Multiple lumened intragastric radium applicators being delivered to the clinician from the radiation department.

somewhat larger balloons. In this way radioactive seeds could be forced directly against stomach cancers by inflation of the two-layered bags. (Fig. 38.) The term, "contact intracavitary radium therapy," should be employed for the method to distinguish it from "distance intracavitary radium therapy" as now secured by the use of centrally situated radium cores. The effects of "contact" radium are analogous to those of contact roentgen-rays or the so-called "Chaoul therapy" previously described. The use of Hames' sutures is not well suited to management of bulky adenocarcinomas, ulcerocancers or other gastric tumors several centimeters thick. The field of contact therapy in gastric irradiation is distinct but limited to carefully selected cases.

1. RADIUM PROTECTION

Activated radium applicators should be handled by 18 to 24 inch forceps. Lead-rubber gloves may be worn to advantage at the time of applicator insertions. Stray gamma radiation no matter how

slight, is cumulative for the radiation worker. When the interior of the stomach, bearing an active applicator, is to be inspected through a fistulous tract, goggles should be worn as in fluoroscopy. A standard radium warning card is attached to the patient's bed throughout the treatment period. This ensures careful case supervision. Hourly inspections are arranged to check on balloon inflations, applicator positions and the general status of the patient. A record is maintained by the nurse in charge and a resident physician is called at once should difficulty of any kind arise. After an applicator has been removed it is promptly put within its protective lead case and the radiation physics department notified. The unloading and disposal of the unit then becomes a departmental responsibility. After the radon content of the core is recalculated and the unit cleansed it is ready for immediate use for an ensuing case. (Fig. 39.)

J. COMPLICATIONS, DANGERS AND SEQUELAE

Difficulties encountered thus far have been decidedly minor. Occasionally an endogastric balloon will leak, due to faulty manufacture, or one will explode within the stomach during inflation. The latter accident causes no more trouble than would any free gastric air-bubble of similar size. Wall disruption from balloon inflation has never been observed; but obviously care should be taken as endogastric bags are inflated within a friable organ. If an air-way becomes occluded where it has been clamped, this passage of the hydrahead must be probed. Patients should be warned to make no attempts to extract inflated applicators. In the presence of jaundice prothrombin levels should be ascertained and vitamin K therapy instituted if necessary as a pre-irradiation measure for the prevention of hemorrhage.

The careful approaches thus far made to administration of full cancericidal doses of irradiation leave it probable that certain of the more serious potential dangers remain yet unknown. Caution is judicious at this stage of clinical applications in order to protect this form of therapy from discredit based on needless overirradiation. Evidence of a mild phlegmonous gastritis were noted in a few early instances of massive dose delivery by the "contact" method; but the distinct limitations of this variant of intracavitary treatment have been stated. Radiation sickness appears to be entirely absent with this form of intravisceral therapy.

K. END RESULTS OF INTRACAVITARY THERAPY

Larger numbers must be treated and more time allowed before final conclusions can be drawn and ultimate end results ascertained.

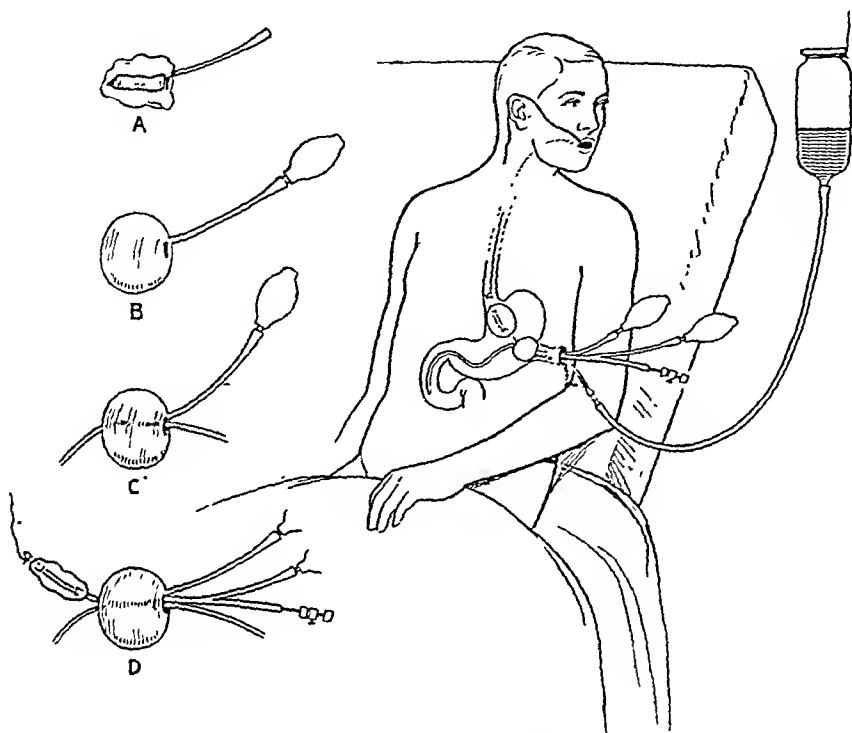


FIG. 40. Retrograde insertion of an intracavitary radium applicator. The patient has swallowed a cord which has been brought to the body surface through a Janeway gastrostomy. The radium applicator has been attached to this cord and drawn into position within the stomach. A feeding tube is also in situ. Both the feeding tube and the radium applicator have been passed through the central lumen of a gastrostomy air-valve, which locks them in position. Inserts A to D show use of Livingston air-valve.

Not until the years 1939 and 1940 was anything approaching a standardization of technic attained. The initial problem in 1937 was that of perfecting endogastric equipment. The five-lumened radium applicator was available only in the current year (1940). Until recently all treatment was confined exclusively to cancers of the cardia and fundus. Certain of these earliest patients displayed unquestionable gains. One patient, for example, treated for a bulky neoplasm of the fundus in 1937 remains symptom free to the present, now almost four years from time of therapy. In this instance approxi-

mately 2,000 millicurie hours of endocavitary irradiation were administered at the single first exposure by a retrograde insertion of a gastric balloon left in situ for three days of uninterrupted treat-

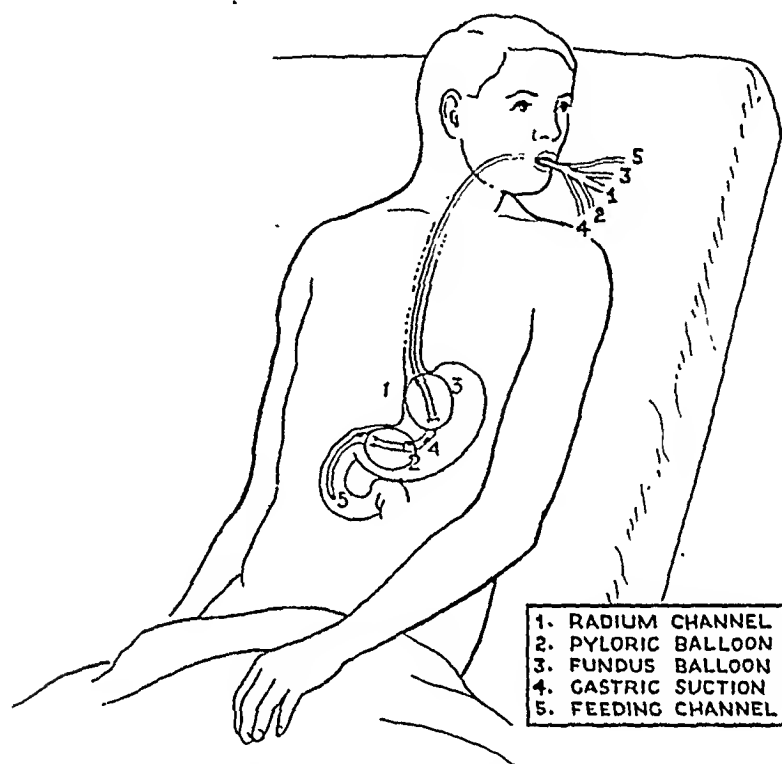


FIG. 41. Oral insertion of an intracavitary radium applicator. At the oral end of the endogastric applicator attachment is made to 1, a duodenal feeding receptacle, 2, a suction device for gastric suction and 3 and 4 to two pressure gauges or manometers. Gastric radiation, gastric emptying, duodenal feeding and inflation to a controlled diameter of either the pyloric balloon or the fundus balloon, or both, can be simultaneously attained.

ment. The tumor promptly disappeared and two years thereafter the gastrostomy tract was closed. Present roentgenograms and gastroscopic studies reveal no recurrence of disease and the weight and appetite remain normal. Numerous additional patients have shown similar steady improvement from the initial treatment administered. An encouraging number already have passed the full estimated period of life expectancy as computed from known survival standards for those untreated or treated by nonexcisional means. Were palliative end results thus far observed to be recorded on the percentage basis, disregarding the small numbers treated, the published figures would prove impressive. (Figs. 40 and 41.)

L. SCOPE OF RADIATION SURGERY AND ENDOGASTRIC IRRADIATION

All patients with cancers of the stomach, save the premoribund or those with resectable tumors, seem suitable for intracavitary irradiation. Known exogastric extensions of the cancer yield no assurance that palliative benefits will not be attained. Death from stomach cancer is rapid if due to starvation, dehydration, hemorrhage or other purely local factors, but tends to be delayed when a result of distant metastasis. This fact is well demonstrated by the published reports on palliative gastrectomy. The average remaining length of life after removing the local disease^{29,30} ranges from one to one and one-half years in various reports even in the presence of known hepatic or other distant extensions. These figures must be contrasted to the average of but two months of remaining life from hospital admission until death for the untreated patients. Any period of renewed strength and regained nutritional balance is welcome. And the significance of seemingly limited gains after irradiation should not be underestimated. To grant one patient with a pathologically verified epithelial malignant tumor of the stomach three years of added life would pass beyond present radiological attainments; while to parallel the net end results of sixty years of surgical at the end of the five year measurement point, management of the disease requires but two to four living patients among *one hundred* unselected cases observed. These scant requirements necessary to demonstrate true radiological progress in this field should constitute a perpetual stimulus to renewed radiotherapeutic effort.

Intracavitary irradiation may be employed as an independent measure and the sole means of therapy, or utilized in combination with external technics. When allied treatments are given, computations should be made of the estimated tissue doses reaching the tumor from each source and in the aggregate. These endogastric applicators are suited, also, to use either with or without preliminary surgery. Yet at the present stage of clinical development any interference with surgical efforts to discover and remove every resectable tumor is not permissible.

There appears ample evidence from a study of the dosimetric and clinical advantages inherent in the equipment and technics described, that a new period of radiological advance in the treatment of cancers of the stomach may be at hand. With methods available

which for the first time can routinely deliver to all parts of the gastric cancer any number of threshold erythema doses desired, with intraluminary applicators developed to a point where they are now capable of delivering in a single treatment depth doses throughout the tumor that hitherto required from two to five weeks of uninterrupted daily exposures, with technical means that allow these debilitated patients during the course of treatment to continue their daily food intake, with reliable demonstrations which reveal that this form of therapy is well tolerated in practical use and with radiation sickness minimal or absent, there is substantial reason to conclude that certain of the goals long diligently sought in the radio-surgical and radiotherapeutic management of gastric cancers have now been attained.

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The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

NEW SERIES VOL. LI

MARCH, 1941

NUMBER THREE

Editorial

THE PROGRESS OF THE SURGERY OF TRAUMA*

PRESIDENTIAL ADDRESS

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THERE never was a time when we stood more in need of a ready and sound knowledge of the cardinal principles of the surgery of trauma than at present. With a great part of the world at war and with our not knowing when an incident may happen which may precipitate our entry into the colossal maelstrom, it is timely for a group of outstanding surgeons to gather and discuss the progress of the surgery of trauma. The far-reaching effects of the good that this association may accomplish can not be estimated at this time.

They are wrong who say that today there are no new surgical frontiers! Growth for a science is not measured by topographical boundaries, but by the expanding needs of our social and economic life.

The opportunities and rewards for the surgery of trauma are greater today than ever because, within the memory of living man, the wilderness has been transformed into great centers of trade and industrial activity. We have ceased trickling through forest trails or trudging over dirt roads in ox-carts or with horse and buggy.

* Delivered at the annual dinner of the American Association for the Surgery of Trauma, Hotel Claridge, Atlantic City, June 7, 1940.

Our civilization has demanded fast transportation and now we speed in highpowered cars over paved roads, in streamlined trains along highways of steel and in commodious planes through the airways of the world. We are, indeed, living today in an age of speed.

The surgeon, always the pioneer, has met with ingenuity and resourcefulness the often disastrous human consequences of these demands of our civilization. What are the pressing and urgent needs today? Well may we pause and reflect on this problem. Today accidents rank fourth—behind only heart disease, cancer and pneumonia—as causes of death among mankind. Never since the world began has there been such a need for surgeons profoundly interested in the broad subject of trauma. In the United States alone, in a year 9,000,000 people are injured, 8,300,000 are temporarily disabled, 330,000 are permanently disabled, and 93,000 die from accidents. The indications are that these figures will increase this year.

Of these fatalities, 34 per cent are the result of motor vehicle accidents, 33 per cent the result of home accidents, 18 per cent the result of occupational accidents, and 15 per cent the result of public accidents of various sorts. Motor vehicle deaths have increased tremendously in the past twenty-five years while the number of industrial fatalities has been lessened 50 per cent. At the present rate, one person in twenty will be injured in an automobile accident in the next five years and there will be at least one fatality for each thirty-five such accidents. The National Safety Council reported that 7,200 persons were killed in motor vehicle accidents in the United States during the first quarter of this year, 450, or 7 per cent, more than in the same period last year. Compared with other types, industrial accidents, contrary to the usual opinion, involve a far smaller number of casualties, fatal or otherwise. A total of 9,000,000 persons killed or injured by accidents during the year represents approximately one-twelfth of our country's population.

Our nation, since its birth in 1775, has engaged in six major wars. In total, these wars extended over a period of fifteen years. The number of American soldiers killed in action or who died of wounds during those fifteen years of war was 244,357 as compared with 456,281 who were killed on the highways during the past fifteen years of peace. Therefore, this national traffic death toll is almost double that of war. Indeed, our American highways have become more dangerous to the nation as a whole than is a battlefield.

Today the problem is larger than any war has yet presented. From the Adjutant General's Office of the War Department comes the record of 143 years:

U.S.A. WARS RECORD

War	Killed in Action and Died of Wounds
Revolutionary War.....	4,044
War of 1812.....	1,956
War with Mexico.....	1,549
Civil War (Union Forces).....	110,070
Civil War (Confederate Forces).....	74,524
War with Spain (including Philippines).....	1,704
World War I.....	50,510
Total.....	244,357

The economic loss caused by accidents in one year is appalling. While one can not and should not attempt to compute the value of human life and limb and crippling in dollars and cents, yet the economic loss is a real and tangible factor and amounted last year to about \$3,330,000,000.

A few years ago it occurred to a few of us that the subject of the surgery of trauma was not receiving the study it demanded. The specialties of late years had become so restricted that various factors, namely shock, infection, biochemistry of traumatized tissues and the mechanical and surgical problems involved in different injuries to various parts and organs of the body were often being subordinated in the constriction of the field to a single part of the body. We reviewed the programs for the past five years of the leading surgical associations in America and found that less than 10 per cent of the total number of papers read before these associations were concerned with trauma. To fill a long-felt need, therefore, and not just to form another society, of which we realize there are plenty, this association was brought into being in 1938. As my illustrious predecessor said last year in his presidential address: "We are calling back into the fold the well trained general surgeon interested in the maintenance of high surgical skill and scientific development in the phases of surgery which have to do with trauma, its immediate and distant effects and complications."

The problem which confronts us is often perplexing and appeals to the imagination, for trauma immediately affects any, or many, parts of the body. The most obvious lesion, a fracture for example, is often the least serious. Internal injuries, the symptoms of which may be for hours vague and confusing, and injuries to muscles, tendons, blood vessels and nerves demand keen judgment and dexterous skill in their diagnosis and treatment. Added to this we always have the great problem of shock in its various stages and burns caused by different agents and of varying degrees.

WOUNDS

In the progress of the surgery of trauma, anesthesia, asepsis, antisepsis and control of hemorrhage have played important rôles but, as Reid³⁹ and Whipple^{46,47} have pointed out, to these must be added another factor, just as important, a better knowledge of wound healing. This means recognition of the fundamental principles of the care of wounds: the avoidance of necrosis, of débris and, as much as possible, of the presence of foreign bodies in wounds. This essential knowledge was possessed by the immortal Paré, whom this association may well honor as one of the fathers of the surgery of trauma.

After trauma, when it becomes necessary to intervene surgically, the technic should, of course, be as atraumatic as possible. The greatest deference should be paid to viable tissues. The surgeon should avoid trauma to them in any way, should preserve always their maximal blood supply and should ever be on the alert to avoid dead spaces or the leaving of clots of blood. At the same time he never should constrict tissues by drawing ligatures too tightly and he should avoid ligatures that are too large or an overabundance of suture material.

Undoubtedly, two of the greatest lessons in wound healing learned during the first World War was the execution of proper débridement and the carrying out of the Carrel-Dakin technic. What I should like to emphasize today is that much of this knowledge is being lost and that many of our interns now leave the services of their hospitals without having been thoroughly trained in this technic. While antiseptics come and antiseptics go, I am of the opinion that Dakin's solution—(0.5 sodium hypochlorite in hypertonic saline solution)—still remains the most reliable one yet discovered. But like so many other good things in life, it is often discarded as having been unsatisfactory when the poor result was actually due to failure on the part of the person using it to familiarize himself thoroughly with the technic. Many advocate the use of azochloramide, a new complex chlorine compound which liberates small amounts of chlorine gradually over a long period in contrast with the rapid liberation of chlorine from Dakin's solution which requires frequent changes of dressings and precautions against irritation. However, he should realize that no antiseptic substance should ever take the place of a thorough cleansing of the open wound with soap and water when dirt and grease are present. This was emphasized by the French surgeons during the first World War who,

for lack of antiseptic substances were often limited to this one procedure and yet achieved satisfactory results. This, followed by copious washing with physiologic solution of sodium chloride, I have depended on for years rather than on the application of antiseptic preparations, because I am of the opinion that antiseptic substances often add insult to injury by inflaming the traumatized tissues by a chemical irritant.

Many wounds, superficial and considered trivial, prove to be fatal. We can all recall, only a few years ago, that the son of the late President Coolidge died as a result of a blister on his heel. This tragedy can be multiplied every year by the thousands. We have all seen the most serious complications follow a scratch or a puncture wound. I heartily agree with Royster^{40,41} that the expression "minor surgery" should be deleted from our medical terminology because any wound is potentially serious and as he said: "The more 'minor' the surgeon, the more 'major' the operation will become before he is through with it."

Absolute rest to the traumatized part plays an important rôle in wound healing, and in the comfort of the patient as emphasized years ago by Hilton, Baron Larrey and Billroth. In fact, these basic and fundamental principles, laid down by the masters of surgery years ago, are as important today as then and to them we should be eternally grateful. As Bernard of Chartres said long ago, perhaps "we moderns are dwarfs standing upon the shoulders of giants."

FRACTURES

When one attempts to review the progress which has been made in the treatment of fractures, he should remember that roentgen rays did not add a principle but only an aid in carrying out the fundamental concept and basic principles laid down by the great master surgeons of the past. Immediate reduction, so far as possible, and complete immobilization are essential. Progress has been made in treating various types of fractures by skeletal-fixation devices in plaster, thereby securing rigid immobilization. This is often better than the use of weights and pulleys. By the use of this method and infrequent dressings, as long emphasized by Winnett Orr,³⁷ Trueta⁴³ reported but six deaths in 1,073 cases of gunshot fracture. In his opinion this method "has given a new direction to surgery."

Metal fixation of fractures by vitallium, an alloy of chromium, cobalt and molybdenum, as brought out by Venable and Stuck⁴⁴ has been a definite step forward in the treatment of fractures. As this

metal is innocuous in the tissue fluids, and produces no electrolysis it, therefore, lends itself to a wide field of usefulness. But a word of caution should be sounded here and that is that this metal or any other ought never to supplant sound surgical judgment with regard to the question of open or closed reduction of fractures. The open operation and the invention of all kinds of gadgets should not lead us too far away from conservative and time-proven methods. We should remember always cardinal principles and also that often what is apparently new is old in basic principle.

The chief cause of preventable deaths in the first World War, as well as in the late war in Spain, was poorly treated fractures of the femur. The British mortality from this injury dropped from 50 per cent to 15 per cent when fixed emergency splinting was introduced.

The treatment of ununited fractures remains a problem today on which we are still looking for more knowledge. From the chemist we may expect more light regarding the regeneration of bone in our search for better methods of bone grafting for ununited fractures.

First aid and transportation of the injured is one of the most important factors in the care of fractures. Often careless handling of the injured person by attendants produces as much damage as, or more damage than, the original trauma. Many a person with a fracture of the spinal column or an extremity is made much worse by the unfortunate way in which he is handled soon after being injured. As surgeons, we are especially interested in the transportation of patients with fractures, and we are, therefore, enthusiastic supporters of first aid training for policemen, firemen, trainmen, ambulance attendants, Red Cross workers, boy scouts and the public generally. We should urge the use of fixed traction in all ambulances. Only by having patients' limbs, necks or spines properly splinted and immobilized can they secure the best chance of having their life saved, of securing the earliest reduction and of suffering the least economic loss.

CHEMOTHERAPY

From all the reports to date, the surgeon undoubtedly has, in sulfanilamide, a most potent aid in the treatment of contaminated wounds and compound fractures; this aid has both a systemic and local protective effect. Aside from antitoxic serums, this is the first protective systemic agent we ever have had which assisted the patient to cope with infection from within. Robert W. Johnson, Jr.,^{29,30} has reported the systemic effect of this drug in treatment of

sixty-seven patients, all suffering from major injuries with severely contaminated, compound fractures. Fifty healed without infection. No infection occurred in any case in which the prophylactic dosage was adequate.

The local application of this drug has been carried out by Jensen^{26,27} and his associates at the University of Minnesota, who reported in 1939 that in thirty-nine cases of compound fracture not a single wound infection occurred. The treatment consisted of thorough débridement, careful hemostasis, introduction of 5 to 15 Gm. of crystalline sulfanilamide into the wound and primary closure without tension. Recently, in a letter, Jensen informed me that the total number of such patients treated has amounted to 101, with an incidence of infection of only 4 per cent. He wrote that "in wounds where extensive loss of soft tissue has occurred, resulting in a defect which cannot be closed by primary suture, careful débridement, followed by packing the wound with many grams of sulfanilamide and in turn scaling the powder in which vasclined gauze strips and then immobilizing the extremity in a plaster cast, will prevent primary wound infection.

"This drug is at present being used on an extensive scale by Dr. Leonard Colbrook⁷ of England, co-author with Dr. Meare Kenny, of one of the first papers to appear in the English language on the use of sulfanilamide in compound fractures."

It appears at this time that we have sufficient evidence to assume that this drug is one of the surgeon's most valuable allies, but as Johnson²⁹ has emphasized: "Chemotherapy complements but does not replace in any way sound and necessary surgical procedure," consisting of thorough débridement, immediate reduction, complete immobilization and administration of serum. The question of sulfanilamide causing delay in wound healing has been intimated by Bricker and Graham⁴ but the prevention of infection is of such major importance that in spite of possible disadvantages the use of this drug is valuable.

ANESTHESIA

Any progress in this science is received by no surgeon more gratefully and eagerly than by the one interested directly in trauma for so often his patients are brought to him already in a weakened condition as the result of trauma, hemorrhage and shock. Because they are in dire need of an anesthetic which will reduce their waning vitality as little as possible, the choice of the anesthetic and the anesthetist

is of paramount importance. Every well equipped hospital should have, as far as possible, a professional physician anesthetist, who will evaluate each individual case and relieve the surgeon from all responsibility of the anesthesia.

AMPUTATIONS

In trauma often a speedy appraisal of the situation and even quicker action is imperative. This is especially true as regards amputations. In the event we are drawn in this second World War many of us will be confronted with the problem of amputation. It would be well to familiarize ourselves with the pronouncements of Baron Dominique Jean Larrey,³³ surgeon-in-chief to the Grand Army of Napoleon, who is reputed to have performed 125 amputations in a day. In his *Mémoires de Chirurgie Militaire*, Paris, 1812, he wrote on the indications for primary and secondary amputations in battle casualties, and their evaluation in the light of his experience in the late war.

BURNS

Of all wounds there are none which demand more urgent and immediate treatment than those caused by burns, no matter what their cause. In few emergencies is a surgeon called on to exercise more skill, judgment, care and energy than in the treatment of an extensive burn. His keenest efforts are concentrated in combating three serious dangers: shock, toxemia and infection. The mortality and the unsightly scarring following extensive burns have decreased considerably since tannic acid, silver nitrate and gentian violet treatment have changed this lesion into that approximating a clean surgical wound, as has been so well shown by Blackfield and Goldman.²

MUSCLES AND TENDONS

Partial ruptures (tears) and complete ruptures of muscles and tendons and dislocations of tendons occur much more frequently than is usually supposed. As the writer has emphasized,¹¹⁻¹⁷ many cases go weeks, months or years incorrectly diagnosed. The presence of a large hematoma in an extremity should make one suspicious of a probable muscle tear and often one is able to see and feel a hiatus. If surgical repair is not done early, contracture and fibrosis often make later repair unsatisfactory; if done early, especially in extensive and complete tears, much time will be saved and a much better ultimate functional result will be obtained.

In lacerations, tests should always be made as emphasized by Bunnell⁵ "before the anesthetic is started to determine whether or not the nerves and tendons are injured. . . . Primary repair of tendons should not be done except under strict indications covering the nature of the wound and adequate facilities of both hospital and surgeon. Operation must be prompt, debridement thorough and all vulnerable parts should be closed over. Repairing within a sheath is the most difficult. Trauma should be minimal and the tendon stitch simple and of non-irritating material, preferably stainless steel wire. This may be left in the tendon or be placed in such a way that the wire is removable."

FACE

Much progress was made in the treatment of this type of injury in the first World War, but no less an authority than Blair³ has written: "Today many are not receiving the most appropriate care. . . . Excepting trauma of vital organs and their essential coverings, the final outcome of no injury is so directly dependent upon early proper care as injury of the face."

HEAD AND NERVE INJURIES

The treatment of head injuries has tended very definitely to conservatism. Surgery is carried out only when very definite and clear cut indications present themselves. Patients with subdural hematomas are today operated on frequently through small craniotomy openings instead of through large osteoplastic flaps and the results of such treatment has proved satisfactory in the relief of symptoms. All operations for acute head injuries should be done, as far as possible, under local anesthesia. The anesthetic solution should be injected some distance from the wound. After thorough débridement of the wound it should be closed in most cases without drainage. In general, supportive treatment directed toward complete rest and an adequate caloric and fluid intake are of immeasurable value. If infection is a probability, chemotherapeutic agents are used freely. It is not untimely to sound a word of warning against the promiscuous use of dehydration therapy, which has a very limited usefulness and may be harmful.

One of the outstanding advances in treatment of trauma of the nervous system has been the recognition and treatment of ruptured *intervertebral disks*. It has been found that this lesion usually presents a fairly definite clinical picture. The surgical attack on this recently

has been so simplified that now muscles need be retracted only on one side of the spinal column, no laminae need be completely removed nor any of the posterior processes disturbed. The results following this procedure, although it is too early to evaluate them accurately, certainly appear to be satisfactory.

In injury to the peripheral nerves a detailed and painstaking examination is of paramount importance. It is sad when one sees today, weeks or months after injury, patients who have had peripheral nerves improperly repaired or even sutured to the severed end of tendons. Such cases are seldom reported but are seen not infrequently. All of this only emphasizes the importance of having patients, who have suffered such trauma, seen by the most competent surgeons.

POST-TRAUMATIC PAINFUL OSTEOPOROSIS

This condition, because of the work of Sudeck,⁴² Gurd²⁰ and Hermann,²⁴ is being more frequently recognized than before and has reacted favorably to interruption of the sympathetic nerve supply to the affected region, thus saving the afflicted many months of suffering and disability.

THORAX

The surgery of the chest has always possessed a fascination and charm for the adventurous surgeon, involving as it does that of the heart and lungs, the most obviously vital organs in the body. An operation on these moving structures will never fail to thrill the most indifferent and cold-blooded surgeon (Hegner).²²

Before the first World War the high mortality resulting from intervention for conditions which were then considered to be sufficiently serious to justify operative treatment impressed surgeons with the idea that operations on the chest were excessively dangerous. Having served in three European Wars, it was my privilege to have seen an enormous number of chest wounds of all descriptions with an abundant opportunity to observe both their immediate effects and the more remote ones, such as those produced by infection.

One of the most striking observations was in regard to wounds opening the pleural cavity—the so-called sucking wounds. It was noticed that with such a wound a man might do fairly well for a short time and then rapidly go into shock and die. The reason was, if we understand the phenomena of shock, a displacement and flapping of

the mediastinum and a lack of oxidation due to inadequacy of respiration. If the admission of air through the wound were stopped, these patients did as well as those with none-sucking wounds. It became the rule, therefore, to close such wounds as soon as possible, even if they were only provisionally sewn together and had to be operated upon and reclosed later. It was found that if shock and flapping of the mediastinum could thus be prevented the patient could subsequently withstand a formal operation in the course of which the wound of the chest wall could be excised and enlarged, the lungs withdrawn if necessary, the wounds in the latter also excised and sutured and the chest finally closed. Closure of the chest, if only for a day or two to enable the final functions to become more readjusted, was found to be imperative. Naturally, under these conditions it was of extreme importance that infection should be prevented and it was therefore necessary methodically to remove foreign bodies, torn and devitalized tissue, and more particularly, fragments of ribs, which were found frequently to provoke infection. It was seen that extensive exposure and handling of the lungs was possible, and our pre-war ideas as to the dangers of thoracic surgery became greatly modified. Much also was learned in regard to the treatment of infection of the pleural cavities, including the empyemas caused by pneumonia as well as those due to wounds.

Roentgenology still remains a chief aid in arriving at the exact diagnosis and extent of intrathoracic trauma. There are, however, a few cases in which a single roentgenogram is not as helpful as the physical findings. For example, there are some cases of localized pneumothorax in which the roentgenogram does not reveal sufficient information that a precise diagnosis can be made but the physical findings will be conclusive. This only emphasizes that we should never get very far away from our basic principles of diagnosis. Among the physical findings, the importance of inspection and palpation cannot be overemphasized. The surgeon today, treating a thoracic injury, should not forget what his predecessors knew and used to good advantage, that is, that to depend solely on the newer and ultrascientific methods is not wise. As always, evaluation of all the factors is essential.

Hemothorax and Pneumothorax. If the fluid or gas is small in amount and is causing no particular symptoms, this condition can be treated conservatively by rest in bed. Removal of air or blood is indicated when there is a sufficient quantity to embarrass the circulation and respiration. Exploratory thoracic operations are only

rarely indicated, and this indication exists when the tear in the lung remains open and the condition does not yield to conservative measures.

In all trauma to the thorax one must try to visualize the condition of the intrathoracic structures prior to the injury in order not to be misled by abnormal conditions which may not be associated in any way with the trauma. In no injuries of the human body can meddling attempts to intervene more greatly jeopardize the patient's chance of recovery than in injuries of the thorax; every movement of the patient adds insult to injury. Briefly, the trend in treatment of thoracic injuries can be epitomized in the word "conservatism."

Heart. In traumatic lesions of the thorax in general, frequent examination of the heart must be made in order to observe any change in its size or position. It should be remembered that the heart can be seriously traumatized by a nonpenetrating injury to the thorax. Such direct violence occurs more frequently than in the past and is often due to compression of the thorax against automobile steering-wheels. Therefore, traumatic myocarditis is no longer considered a myth. Beck¹ believes that "the heart is the recipient of many injuries" and that most of them "are not recognized." Here again, one must attempt to form some idea of the integrity of this organ prior to the injury, and any progressive changes that may thereafter appear. The immediate prognosis in the presence of wounds of the heart depends chiefly on the interval between injury and operation as shown by Elkin⁹ in a review of twenty-two stab wounds.

ESOPHAGUS

External injury to this organ is so rare that it does not warrant discussion in this review.

ARTERIES AND VEINS

If an acute injury of a main artery to an extremity necessitates ligation, ligation of the accompanying vein should be considered. A useful but not absolute test in determining whether or not the main vein should be ligated is that advised separately by Henle²³ and Coenen.⁶ This test relies on a retrograde "flow of blood from the open end of the distal arterial segment, the proximal portion being compressed, as an indication of satisfactory collateral circulation." If the sign is positive, ligation of the accompanying vein is contra-

indicated; and when this sign is negative, ligation of the main venous channel is advocated.³⁸

ABDOMEN

Abdominal injuries, whether caused by penetrating wounds or a contusion of the abdomen with resulting visceral damage, are accompanied by a mortality rate of 50 per cent.³¹ The mortality depends (1) on the type of injury, (2) on the time elapsing before operation, and (3) on the structures involved. In order to reduce this mortality we must emphasize more and more the importance of having these patients transferred immediately to a hospital where they can be thoroughly examined and observed constantly. After they have recovered from their initial shock it is often more prudent, in case of doubt as to visceral perforation, to perform an exploratory laparotomy rather than to delay too long.

Gastrointestinal Tract. Of the hollow viscera the small intestines are the most frequently injured, the large intestine next and the stomach least frequently. Rigidity of the abdominal wall, which is first localized and soon begins to spread, is always present. "When to operate" as G. G. Davis writes⁸ is the all important question in internal injuries of nonpenetrating force. It is generally recognized that in this type of injury operation should be preceded by the treatment for shock. The demonstration of gas in the free abdominal cavity is a definite sign of perforation and calls for immediate operation.

Often when the abdomen has been opened the proper surgical therapy tries the ingenuity of the most experienced and versatile surgeon. In a word, the intervention should be brief. That procedure which will close all perforations most quickly and with the least amount of shock, is the one which should be selected. One must decide in a few moments the question of exteriorization, of resection or of enterostomy.

Traumatic Appendicitis. The incidence of this condition is not so important as is the fact that the disease exists as a clinical entity. It is a subject in which employers of labor and accident insurance companies are deeply interested.³⁵

Liver. The liver is injured more often than any other internal organ because of its composition. Gunshot wounds comprise about 60 per cent of the wounds to the liver. The others are caused by falls, automobile accidents and stabs. Graham¹⁸ writes that "the diagnosis of liver lesions is often not possible until the next day. If it cannot be

based upon abnormal dullness then we must depend upon the disappearance of liver dullness produced by gradually developing tympanitis caused by hematomas or injuries interrupting the nerve impulses at the base of the mesentery."

Krieg³² has reviewed sixty cases in most of which the patients were seen soon after the accident and in which the total mortality was 61.6 per cent and the postoperative mortality 56.6 per cent. Shock from trauma was found to be the most common fatal complication. Superficial wounds may be approximated by suture but deep wounds should be treated by small drains inserted deeply. Krieg expressed the opinion that abdominal drainage should be instituted in all cases.

Graham¹⁸ says "suture is the ideal method; packing for an emergency. The greatest skill is haemostasis; the greatest error, hasty examination; the greatest virtue, speed."

Green¹⁹ believes that glycosuria probably occurs frequently following liver injuries.

Injuries to the gallbladder or bile ducts are not encountered frequently but when present demand immediate surgical intervention. According to LeRoy Long³⁴ "the history of a crushing injury of the right upper abdomen, followed in a few days by a slight jaundice, bile in the urine, absence of bile in the feces, and later, usually a week or ten days, a distended abdomen, flat on percussion, practically establishes the diagnosis of rupture of some part of the biliary tract." Paracentesis may cinch the diagnosis.

Spleen. Injuries to the spleen occur about half as frequently as injuries to the liver. As Foster¹⁰ has shown in an analysis of twenty cases in which operation was performed, diagnosis is not made as frequently and as early as it should be. He emphasized localized abdominal rigidity and shifting dullness as the two important diagnostic signs; preoperative transfusion and autotransfusion as life saving procedures; splenectomy as the treatment of choice. Webb⁴⁵ has found elevation of the diaphragm on the left side, as well as cloudiness in the region of the spleen and displacement of the stomach towards the right, as revealed roentgenologically, to be helpful. Delayed intra-abdominal bleeding (ten days) from a fractured spleen has been reported by Jones.³¹

Pancreas. Isolated injuries of this organ are rare. A complete laceration of the organ may liberate the pancreatic secretions with resulting pancreatic digestion and necrosis following. Unless repair with drainage is established death usually ensues.

The postoperative care is essentially that of acute peritonitis. Morphine in adequate doses, abdominal decompression by the Wangensteen method and the preservation of a fluid balance can not be overemphasized.

Peritonism or traumatic peritonitis, called by some "sympathetic or abdominal shock," must be kept in mind as it may be caused by the presence of a fractured vertebra. The clinical picture is one known as a "knock-out," so severe is the shock. There is intense pain, nausea and vomiting, board-like rigidity of abdomen, diffuse tenderness and absence of peristaltic sounds, rapid pulse and low blood pressure. A laparotomy would seem imperative but traumatic peritonitis readily subsides and disappears under primary treatment for shock (Hertz and Stalker).²⁵

UROLOGICAL TRACT

Kidney. This organ, because of its well protected position, is not often injured. When trauma does occur, however, it is frequently serious because of the important secretory function and rich vascularity of the kidney. A contusion or rupture of this organ may be a complication of fracture of the vertebrae or bony pelvis. Hematuria, following injury, should always make one suspect renal trauma and then, by repeated physical and urinary examinations, measurement of the fluid exchange, examination of the blood, roentgenographic examination and pyelography, one should be able to arrive at an accurate diagnosis. The absence of hematuria, however, when other signs of renal trauma exist, is suggestive of complete laceration or occlusion of the ureter.

Conservative treatment usually is indicated in cases of renal trauma. According to Harrison,²¹ who recently analyzed twenty-seven such cases, "There is a tendency for spontaneous improvement owing to the processes of natural repair. The absolute indications for operation are persistent hemorrhage, urinary extravasation, or renal infection."

Bladder. Early recognition is imperative as the mortality rises terrifically after the first few hours following injury. Johnson²⁸ stated "that after 24 hours the mortality jumps from about 10 per cent to 40 per cent or even 50 per cent." Only by early recognition and immediate operation can this be reduced. When on physical examination the findings are inconclusive, early diagnosis can be made most accurately by proper application of the cystogram.

Urethra. When this lesion occurs, immediate end-to-end anastomosis should be performed. A retention catheter should not be inserted but the urine diverted by suprapubic cystostomy. This procedure is to prevent the formation of intractable stricture.

PSYCHIC TRAUMA

At present the great mass of the injured are treated in general hospitals. The patient is seen by the visiting surgeon but often the treatment is entrusted to a less experienced man. Frequently the attending surgeon is one who has little interest in, and who has given little time to, the surgery of trauma and to the great development made in it during the past few years; he may care nothing at all about industrial relations. The injured, who is entitled to the best scientific treatment of the day, not infrequently finds that he is not in the most skilled hands and that, as an industrial case, he is regarded in the hospital as a nuisance. Even if he is fortunate enough to fall into skilled hands, and the immediate treatment or operation is performed properly and well, what often follows? For weeks, and not infrequently for months, the patient is left often to his own devices. Lying there in idleness, with worry and melancholy his chief companions, is it any wonder that traumatic neurosis develops? Satisfied with a good surgical end result, very little thought is given to the injured patient's future economic usefulness. We should remember, therefore, that detrimental psychic reactions usually accompany deformities following injuries. The surgeon must not lose himself in the problem of the repair of the physical trauma and overlook or neglect the psychic trauma, with the result that "the most perfect restoration may be utterly unappreciated."³ The treatment of both should go hand in hand or the surgeon has not measured up to his full obligation. We should always remember that we are not just artisans or technicians but physicians and philosophers in the broadest meaning of the words.

The services of many of our large hospitals and teaching institutions should be reorganized in order to treat more effectively injured patients. Today there is often confusion because of the unscientific and entirely unwarranted methods of assorting traumatic patients among various specialists according to the organs affected. For example, a patient with an injury to his chest and a fracture of the femoral neck is assigned to a thoracic surgeon with the result that the femoral fracture receives only scant attention; a patient with a severe head injury is assigned to an orthopedic surgeon because of an

associated fracture of a long bone; a patient with an acute fracture is referred to an abdominal surgeon, while one with an ununited fracture is referred to an orthopedic surgeon. We have all known of cases of conspicuous fracture and associated rupture of the bladder or other viscus, in which the latter would be undiagnosed for hours because the patient was referred to the fracture service. Again, a patient may be injured in an industry and be classified as an industrial case. This is absurd. Trauma, whether received in the factory, at home, or on the highway does not differ and the same fundamental principles of surgery apply.

TREND TOWARDS SPECIALISM

It is to be expected that the trend today in everything is towards specialism and this is certainly true in the rapidly expanding field of general surgery; but this can be carried too far. If we visualize the future we can be sure that this world will continue to become more mechanized and to accelerate its speed and the result of this will be an increase in trauma. To recognize immediately the broad problem presented, to treat adequately the seriously injured, we should have surgeons with as extensive a general experience as is possible to attain. Only by so doing can we expect to cope with the surgical exigencies of this rapidly changing world. To do this efficiently, our medical schools will have to give more time to the teaching of this important subject. I realize that the curriculum is already overcrowded, but, like many other decisions in life, the less essential must give way to the more essential. Recent graduates will have to treat many more patients with trauma than they will patients suffering from brain tumor, goiter or bronchiogenic carcinoma.

Our association should develop and promulgate fundamental principles in the care and treatment of the injured. This information should be made available to the physicians working in the smaller institutions throughout the country to enable them to treat more efficiently their patients with acute trauma. We should strive to get the co-operation of administrative staffs of hospitals, large and small, to recognize the importance of being equipped at a moment's notice to care adequately for the seriously injured. They should realize that the first hour of injury is the most important one.

We have, therefore, a great opportunity to improve and standardize the methods of the surgery of trauma, affecting the small hospitals in the rural districts as well as the large ones in the great metropolitan centers. That the Fellows will meet this opportunity I

entertain not the slightest doubt. If we succeed in this, the medical profession and hospitals in America will be prepared at any time to be of vast help to the Army and Navy in time of war. Anything that we can do to stimulate the education of the lay public in the care of highway accidents should be done. The American Red Cross has established almost 3,000 Emergency First Aid Stations along our highways. It has, through its Chapters, certificated approximately over two million persons as having completed courses in first aid under regularly qualified instructors.

I ardently wish that it had been in my power to weave together more completely the fruitful contributions that have come from many of you which have played such an important part in the progress of the surgery of trauma. I fully realize how incomplete this review has been but I hope, nevertheless, that it is apparent that much important work is to be done. If done, a movement will be set in motion which will prove a vast fund of permanent value not only to our present generation but to generations to come.

As one of the founders of the American Association for the Surgery of Trauma I am justly proud of the success it has already achieved but I should like to see it become more than a surgical society, more than a scientific body; I should like to see it become a great and potent influence in shaping and moulding the careers of the younger generation of American surgeons and of saving more lives all over this continent. If any of you, however, think this is but a dream, then I say to you, let us cherish it just the same and hope it will come true. That dreams may accomplish much, I need only close with this story.

According to the literature of ancient Ireland there was a great musician by the name of Dagda who played a harp which had only three strings, but from which he produced the most marvelous music. It was said that when he struck the first string, the music made the women weep because it was the immemorial music of woe, and when he struck the second string, the music made the young men laugh because it was the immemorial music of mirth, but when he caressed the third string, the music brought consoling understanding and soothing peace and gladness to all because it was the immemorial music of dreams.

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Original Articles

THE TREATMENT OF FRESH WOUNDS

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A WOUND is a break in the continuity of tissue. Usually we think of it as a break through the skin only. In reality a wound of the deeper structures is more important than that of the integument.

The type in which we are interested in this discourse is that which comes from trauma. These are divided into three classes: (1) those caused by impact from without, (2) those caused by rupture from within, and (3) those produced by burns. Among the contact wounds are abrasions, contusions, punctures, incisions and lacerations. The insults to the tissue vary from slight, superficial abrasions with destruction of the outer covering of the skin to the more severe and destructive injuries of the muscle tendons, nerves, blood vessels, bones and viscera. Slight abrasions if infected may become a problem as serious as the more extensive lacerations. The former are usually neglected; the latter are always treated. The wounds caused by rupture from within are exemplified by the compound fracture in which bone structure is forced through the skin. These openings may be very small, often only a blister or even a microscopic opening. They may be quite large where spicules of bone protrude through the skin from within. Wounds caused by burns are due to actual flame, contact with hot objects, electrical currents and chemicals.

The treatment of all of these wounds is as varied as the degree and extent of the injury, the structures involved and the causative factors.

All *treatment methods* must be efficient, practical, simple and economical. Treatment must have as its object (1) hemostasis, (2) treatment of shock, (3) tissue immobilization and relief of pain, (4) prevention of infection, (5) eradication of infection if such exists, (6) promotion of healing, (7) re-establishment of function with the least possible morbidity and disablement, and (8) reduction of the

economic loss to employer and employee. These are enumerated in their order of emergency.

Hemostasis is easily accomplished except in the punctured and lacerated wounds and compound fractures. It should be brought about early with the utmost speed and accuracy. Mass ligation should not be done. Ecchymosis, a hemorrhage into the skin, is of little consequence, but hematomas, especially when large and of the dissecting variety along the tendon and muscle sheaths and bone, may produce a definite problem. Large collections of blood should be evacuated and the source of the bleeding stopped. Elevation of the extremity should always be done since it lessens the blood to the part.

Shock resulting from exposure, extensive hemorrhage and trauma to viscera, nerve trunks and nerve centers as well as from extensive bone and muscle injury must be combatted early by the well known methods, namely, morphine to promote rest, fluids to supply the blood lost, blood transfusions and blood plasma.

Tissue immobilization relieves pain, hastens the repair of injured tissues and is easily brought about by strapping, suturing and splinting. In all tendon and nerve injuries and all larger wounds and especially those involving bones and joints, this is of the greatest importance.

Prevention and eradication of infection and aids for promotion of healing will be considered under one heading. Precisely what is your procedure of wound treatment? As I stated above, any treatment method should be efficient, practical, simple and economical.

In the same manner that many have sought a short road to success so we have too often attempted to find a "short cut" to wound healing. It seems to me that we spend too much of our time going about looking for "false gods." We have too often been unwilling to put forth the necessary units of energy to gain our best results. If one can bring about wound healing by the laying on of hands, by the oral administration of drugs, by pouring medicaments into a wound, why wash and scrub and work? If we can benumb our conscience and satisfy our patients by showering into the wound quantities of highly colored and often brilliantly hued medicaments, why not? The objection is that most wounds cannot be healed that way.

For many years an ideal antiseptic has been sought. Many have been brought forth, some of value, others without value, some entirely useless, others even harmful. Some are innocuous; others destroy a few of the organisms but also some of the good tissue. We

all recognize some of our former "allies" when I speak of iodine, mercurochrome, mer cresin, merthiolate, the various chloramines and chloramides, triacetin, gentian violet, picric acid, zinc peroxide, etc., etc. I do not wish to be understood as saying that under certain circumstances some of these may not have value. Iodine still has its place in the preparation of skin, and zinc peroxide, as brought out by Meleney,¹ seems to give that author some satisfactory results. However, I believe that none of the preparations mentioned is an ideal antiseptic for universal treatment of traumatic wounds.

It seems to me that we have lost the trail blazed for us a quarter of a century ago when Carrel and Dakin in December, 1914, began their monumental work at the French Military Hospital No. 21, at Compiègne.

During the World War the Carrel-Dakin method was used very extensively. It was acknowledged by many as the most outstanding method of wound treatment since Lister. Results hitherto unequalled were reported. The literature contained numerous and outstanding articles in the medical journals abroad and in this country. Notably among these were papers by William O'Neill Sherman^{2,3} and Frank D. Smythe.⁴

The Rockefeller Institute for Medical Research, beginning in 1917, gave a thorough course of instruction in the treatment of wounds by Carrel's method. In subsequent years numerous modifications were suggested by Carrel and others, but none seem to have stood the test of time.

Over all these years Sherman has never discontinued the use of the Carrel method of wound preparation and the use of sodium hypochlorite solution and has reported their use in a large series of cases.

Among others who successfully continued the use of Dakin solutions were Kanavel and Koch,⁵ Young⁶ and Rhodes.⁷

Another noteworthy contribution came to me recently from Dr. E. P. Sullivan, a noted veterinarian in Saratoga Springs, New York, who has used sodium hypochlorite solution in his practice on thoroughbred cattle and race horses over a period of many years. I quote:

"A physician returning from the World War in 1918, told me the wonderful success they had with treating wounds with Dakin's Solution. Before that time I used mostly the coal tar products, iodine, etc., and if you use any of them strong enough to destroy microscopic organisms they will irritate the tissues. I prepare the tissues as recommended by Carrel. If I can get to a wound before infection

sets in I get healing by first intention, and if the wound is infected by keeping wet packs on it of a one percent solution it will destroy in a very short time any organisms that have invaded the tissues. I have never found any case where I have used it where I have not received excellent results. I have never used it in the eye, but in any throat infection I have I keep syringing the mouth out every two hours with a one percent solution and get wonderful results. I use it for a mouth wash for myself night and morning. It will destroy streptococci, the causative factor in septic sore throat. There are many kinds of chlorine preparations on the market, but I find sodium hypochlorite has more available chlorine and is given off quicker than any of the other solutions. It will destroy mostly all organisms. A few of the exceptions are tuberculous and anthrax. There might be a number of others. I make it up fresh as I get better results this way. It is the most marvelous antiseptic that has ever come into my hands in thirty-four years of practice as a veterinarian. Would consider it an honor to have you quote me in your paper."

A further review shows that many authors mention the use of the Carrel-Dakin method but state that the sodium hypochlorite solution is not practical because of its instability and because of the time and labor required in the preparation of the solution. For a number of years now a concentrated solution, which has as its active ingredient sodium hypochlorite, has been available in a product known as "hychlorite." From this a stable and entirely efficient solution may be made by adding one part of hychlorite to seven parts of sterile saline solution or sterile distilled water. This gives a solution of sodium hypochlorite of approximately .45 to .5, which is the ideal strength. Any higher concentration would irritate the skin and lower concentrations would not as rapidly destroy the organisms nor dissolve the necrotic tissue in which they lie. Titration of this solution is not necessary. It is quite stable since it retains its strength for a week or ten days. It is essentially nonirritating, noncaustic and nontoxic and has a high bactericidal and solvent power. Thus the objections so frequently mentioned no longer exist.

The treatment of wounds according to the Carrel method is divided into two very distinct parts: (1) the thorough preparation and débridement of the wound and (2) the application of the sodium hypochlorite solution.

If I go into detail which seems unnecessary, let it be for those who read, not necessarily for those who listen. We all agree that the most important part of wound treatment and the prevention of infection

is the thorough preparation of the wound itself. *This cannot be over-emphasized.* The cleansing and débridement must be done with surgical precision and scrupulous asepsis. As a standard procedure, the wound, large or small, is first covered with sterile gauze which is saturated in a .5 sodium hypochlorite solution. The surrounding surface is then washed and scrubbed thoroughly and repeatedly with liquid soap and sterile water, care being taken not to wash infection from the skin into the wound. After this has been thoroughly accomplished, the shaving of the skin far and wide of the incision is done. Again the skin is thoroughly cleansed of grease and other inabsorbable material by the use of soap and water followed by ether. This done, the wound itself receives our attention.

In the more extensive cases an intravenous anesthetic may be used or the tissues may be infiltrated with 1 per cent novocaine injected around the edges of the wound. The wound is thoroughly washed with copious quantities of soap and water and flushed with sodium hypochlorite solution. All corners of the wound are examined, bleeding surfaces are ligated and loose tags of tissue such as skin, fat or fascia, or loose pieces of detached bone or foreign material are carefully removed. It is necessary that all tissue hopelessly bruised or impregnated with dirt should be eradicated. Wound edges should be dissected until a healthy bleeding surface is obtained. The wound is flushed with sodium hypochlorite solution. It is not always possible to tell from the primary examination which of the tissues are completely devitalized, therefore, a secondary débridement on the second, third and fourth days is occasionally necessary. This is very important since the antiseptic solution destroys only those organisms with which it can come in contact and does not necessarily destroy those which lie in necrotic tissue or under the surface of granulation masses. It is also very important that the skin around the wound be thoroughly cleansed at each dressing.

The wound is now ready for the application of .5 per cent sodium hypochlorite solution in the form of moist dressings or, as is the case in the larger, deeper and more irregular wounds, the introduction of the well known Carrel tubes. Because the solution is antiseptic for a limited time, it is necessary to flush with a sufficient amount of Dakin's solution every two hours. When Dakinization is contemplated for more than several days, it is well to protect the skin around the edges with vaseline gauze since one cannot tell which skin is going to become irritated by the constant contact of this solution. These irrigations are continued until the wound is beginning to heal

and is free of all signs of infection. In superficial wounds, abrasions or minor bursting lacerations the application of the sodium hypochlorite is necessary for one or two days only.

We make every effort to see our patients within the first six hours after injury. Most of them are seen within the first hour. Too much importance cannot be placed upon the fact that early healing is imperative if we wish to prevent scars and secondary infection as well as excessive lost time on the part of the workman. Primary healing is our first aim and is easily accomplished when one deals with a fresh wound in its early stages. The greatest enemy of primary healing is infection. We realize, of course, that all wounds are contaminated. Not all wounds are infected. In fact, infection comes secondary to contamination. Experience has shown that it takes from three to five times as long to heal an infected wound as one which is merely contaminated.

When once a wound has become infected, débridement of necrotic tissue and thorough drainage plus repeated sterilization of the surrounding skin and the introduction of sodium hypochlorite solution by way of Carrel tubes into all the recesses of the wound is imperative. In 1930, Kanavel and Koch⁵ wrote: "Infection will continue unabated as long as there is necrotic tissue present in the wound. Tissue which is obviously necrotic can safely be cut away. If no definite line of demarcation is present, 'chemical debridement' is safer than excision. We know of nothing more effective for this purpose than Dakin's solution. As was pointed out many years ago, Dakin's Solution properly prepared has the power of dissolving necrotic tissue without injuring the living tissue. It has, therefore, a very definite place in the treatment of suppurating wounds with profuse wound discharge and dead tissue in the floor of the wound. To obtain the best results it must be used in accordance with the technic outlined by Carrel and Dakin, i.e., the solution must contain .45 to .50 per cent sodium hypochlorite, it must not be excessively alkaline and it must be applied over the entire wound every two hours.

"As soon as the necrotic tissue has separated the wound very rapidly takes on a healthier appearance. Red granulation tissue begins to appear in the floor of the wound and the wound secretion is perceptibly diminished."

Much has been said in the literature concerning primary and secondary closure of wounds, but surgical judgment and experience must guide the surgeon in his decision as to when the wound should be closed.

In all compound wounds, even though pinpoint, as well as puncture wounds of all types, the underlying structures must be exposed by free and open incision so that the underlying structures as well as the bones may be thoroughly examined. In compound fractures we have two objects in view: (1) prevention of infection and (2) realignment and healing of the bone fragments. In my opinion there is no contraindication to applying some type of internal fixation if it is necessary to hold the bones in place. The internal fixation can very readily be removed after it once has been shown that the fragments will not dislocate. Infection can be prevented by repeated débridement and by continuous application of the sodium hypochlorite solution until the structures around the bone have been completely healed. Osteomyelitis should not occur if the patient is under our care from the beginning.

Compound wounds into the abdomen and chest cavity tax the surgical judgment to the utmost. Early interference may occasionally give disastrous results. However, I believe that one should attack these cases with radical surgery if there is any doubt as to the damage done in the cavity. Delay in these cases may spell disaster, and I believe that one had better operate too often than not often enough. Opening the abdomen and inspecting its contents will do little harm and may save the patient from a long continued peritonitis if not ultimate death.

In all early wounds, especially those seen within six hours, tendon suture as well as nerve suture is indicated. If there is soiling of tissues or not, sodium hypochlorite solution is applied and the wound is closed or left open a sufficiently long period of time to insure freedom from subsequent infection.

When the open wound is due to a burn, the necessary débridement is done at once. The wound is cleansed with sodium hypochlorite solution .25 to .50 per cent following which the paraffin wax is used. The wax dressing is applied as often as necessary, i.e., daily or on alternate days, depending upon the degree of the burn and the amount of wound secretion there is present. In the more severe burns repeated débridement of necrotic tissue is done as the case demands, each time spraying the paraffin cover over the entire burned area. Wounds treated in this way have healed with amazing rapidity and with a minimum of scar formation and contractures.

There are certain *aids in the promotion of healing* which should be mentioned, especially as concerns the subacute and chronic wounds. In the last fifteen years the use of vaccines, bacteriophage and

bacteriophage enzyme has been frequently cited in the American literature. Much has also been said of toxoids, toxins and antitoxins. Much has been written on the use of prontosil and neoprontosil, on sulfanilamide and sulfapyridin and more recently on sulfamethylthiazol for staphylococcic infection. The last named has now been withdrawn even for experimental purposes. In the discussion of these chemical agents in the prevention and treatment of infections resulting from industrial wounds, one must conclude that at best they are only aids and must not be substituted for the recognized methods of treatment. There is yet no "short cut" to wound healing. The treatment of wounds with the x-ray in the hands of some has brought about a promotion of healing, and I can readily see that in some of the deeper wounds it might have some value.

In those patients in whom there has been a considerable amount of shock and a prolonged loss of body fluids complicated by subacute or chronic infection, a high grade of anemia may readily develop. In these the various medicaments which have been described in the literature are of value. In my experience there is nothing which will give such spectacular and rapid results as maintenance of fluid balance and repeated transfusions of blood. We should be very familiar with the excellent work of Scudder and Drew³ with reference to controlled fluid therapy.

The treatment of existing dyscrasia is so pertinent that it need only be mentioned.

Re-establishment of function with the least possible morbidity and disablement is highly important. When once the tissues have healed sufficiently, physical therapy, including hydro- and electrotherapy must be begun. This applies especially in the deeper wounds, after fractures and joint injuries. Nothing is more hopeless than an extremity in which the muscles, tendon sheaths and skin though healed are all massed together by adhesions, frequently produced by prolonged immobilization in plaster casts and splints. Early active and passive motion, massage, the whirlpool bath, short wave diathermy and muscle re-education and stimulation with the Morton Smart apparatus, all are valuable aids in the re-establishment of muscles, tendon, nerve and joint function. It is my opinion that the Physiotherapy Department is one of the most important departments in the hospital where traumatic wounds are treated. There is probably no other method of treatment in which there is so much "hocus pocus," so much of heat and light treatment which is entirely useless. There is too much of infra-violet and ultra-red, and I confuse

these terms advisedly. I am reminded of the man who had twenty-eight light treatments in twenty-seven days. Rehabilitation of structures calls for the rational application of physical therapeutic agents guided by cortical cells.

The patient himself can aid materially and should be encouraged in the normal use of his extremity at the earliest possible moment and continue to do so every day. A wound is not really healed until rehabilitation of injured tissues is complete. It is only by the applica-

TABLE I
CLASSIFICATION OF 20,557 OPEN WOUNDS (G)
Years 1938-1939

Abrasions	4,485
Burns 1° and 2°	2,214
Burns 3°	131
Burns of eye	178
Lacerated wounds	8,441
Incised wounds	3,047
Puncture wounds	1,409
Infected wounds (seen 6 hours to days later)	340
Infected wounds (seen within 6 hours)	2
Fractures, compound	265
Amputations	45

TABLE II
CLASSIFICATION OF 5,732 OPEN WOUNDS (S)
Years 1938-1939

Abrasions	1,399
Burns 1° and 2°	1,156
Burns 3°	2
Burns of eye	14
Lacerated wounds	2,560
Puncture wounds	376
Infected wounds (seen 6 hours to days later)	142
Infected wounds (seen within 6 hours)	1
Fractures, compound	74
Amputations	8

tion of all surgical, medical and physiotherapeutic principles that our best results can be obtained and that there can be a greater reduction of the economic loss to the employer and employee.

The treatment of wounds has for its object complete wound healing with the least amount of morbidity or disablement. We must at the earliest possible moment make a producer of him who might otherwise be a burden to society.

At one time or another we have tried most of the treatment methods. We have gone through all the phases from the oatmeal poultice to maggots, from the primary closure of all wounds to the

well known vaseline pack. We have watched the pendulum of treatment swing back and forth only to go back to the trail blazed for us a quarter of a century ago by Carrell.

TABLE III
COMPARATIVE STATISTICS OF 1936 AND 1939

Abrasions (Not into Deep Structures)	Year 1936 When Iodine, Mercuro- chrome, Metaphen or Alcohol Was Used	Year 1939 When Carrel- Dakin Solution Was Used
Total cases....	899.0	760.0
Total dressings.....	3200.0	2010.0
Days required for healing.....	5854.0	2764.0
Average days required for healing.....	6.51	3.63
Infected cases (first attention).....	4.0	None
Days required for healing infected cases....	87.0	None
Average days required for healing infected wounds	21.75	None
Per cent of infected wounds....	0.4	None

TABLE IV
COMPARATIVE STATISTICS OF 1936 AND 1939

"Through Skin" Lesions (Including Lacerated, Contused, Incised, Compound Wounds and Compound Fractures)	Year 1936 When Iodine, Mercuro- chrome, Metaphen or Alcohol Was Used	Year 1939 When Carrel- Dakin Solution Was Used
Total cases .	805.0	700.0
Total dressings .	6199.0	3971.0
Days required for healing .	13,219.0	7589.0
Average days required for healing .	16.42	10.84
Infected cases (first attention)	51.0	1.0
Days required for healing infected cases	2040.0	11.0
Average days required for healing infected wounds	40.0	11.0
Per cent of infected wounds.	6.3	0.00014

Tables I, II, III and IV present tabulation of our results with a large number of cases. One will note with satisfaction that very many are of the minor injury class in which there is no time loss and no subsequent morbidity.

CONCLUSIONS

The results obtained in treatment of 26,289 open wounds with only three infections in those cases seen within the first six hours speak for themselves. This is entirely due to the careful painstaking preparation of the wound, maintenance of asepsis and the application of sodium hypochlorite solution.

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THE USE OF B.I.P.P. AND LIQUID PARAFFIN IN THE TREATMENT OF WOUNDS*

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THE B.I.P.P. treatment of wounds has been heard of by the majority of surgeons. It has been used by many but the real principles underlying its use have apparently been understood by comparatively few. The majority of those who have mastered this technic state most emphatically that without it, the surgery of trauma and of infected cases in general would be at best a much more difficult matter. We believe that continuous experience in the use of such a method for a period of more than twenty-three years should qualify us at least for an expression of opinion as to its value and safety. We believe that practically all objections to this method have arisen either from a lack of knowledge of the primary principles involved or from a faulty application of those principles.

B.I.P.P. was originally used by Mr. Rutherford Morison during the war of 1914 to 1918. Mr. Morison was at that time Professor of Surgery at Durham University. Like many other very good things, it was immediately misused to an extent that was positively alarming. One of us (L. H. McK.) well remembers those early days. I can still picture certain cases admitted to my ward in the Base Hospital. Knee joints were packed with as many ounces of B.I.P.P. as they would hold. I remember one chest wound with excision and tight closure, with more than six ounces of B.I.P.P. lying free in the pleural cavity. The records of our Hospital (No. 3 Canadian General) show a protest by the Commanding Officer of our surgical division regarding the arrival of certain patients with wounds packed with B.I.P.P. and yet having their superficial dressings changed and soaked every four hours with Dakin's solution.

In spite of such fearful procedures it was noted that, particularly when pressure of work prevented meddlesome interference, a large number of the B.I.P.P. cases were arriving in much better shape than those treated by any other method.

During the spring of 1918, one of us (L. H. McK.) had the privilege of being associated with Mr. Morison for a number of days

* From The Montreal General Hospital.

during which time he visited certain medical units in France to demonstrate the essential principles in his technic. Among the advantages claimed for the method are:

1. Relief of pain.
2. Stimulation of a healthy reaction on the part of the tissues and control of original infection.
3. Infrequent dressings with consequent: (a) Avoidance of secondary infection; (b) avoidance of pain; (c) economy of dressings; and (d) conservation of time of both surgeons and nursing sisters.

For the achievement of these desiderata a thorough understanding and careful application of certain principles and points of technic are necessary. These are:

1. Mechanical cleansing of the wound with removal of all obviously dead tissue and also such tissue as seems likely to necrose.

2. Secure a *dry* wound. This must be accomplished not only by control of gross bleeding by means of ligatures or pressure, but by dehydration of the wound surface with alcohol in order to permit the necessary and complete application of the B.I.P.P. and liquid paraffin to all parts of the wound, with special reference to deeply placed interstices. Only thus is "curtain drainage" effective.

3. Complete relief of tension in the wound. We must remember that the primary object of incising an infected area is to improve circulation through the part by relief of interstitial tension and not to simply evacuate pus. We have made it a practice not only to carry out whatever division of skin and subcutaneous tissue and more particularly of fascia may be necessary to relieve tension already established, but to extend such incisions sufficiently to anticipate such inflammatory swelling as may be expected.

4. Rub B.I.P.P. thoroughly into all parts of the wound and then remove any excess with dry gauze. The amount that can be used is important. If large quantities be left in a wound poisoning, either by bismuth or iodoform may of course result. As a rough guide it may be said that not more than a desertspoonful (2 drams) should be used in any case. If all excess be removed, there remains but little danger. If a large area (more than 144 square inches) is to be covered, one may dilute with liquid paraffin. If there are multiple wounds whose total area seems likely to exceed this danger limit, we prefer and recommend that the use of B.I.P.P. be reserved for the more serious or the more grossly contaminated wounds and to treat the less important by other less effective measures such as the Carrell-Dakin method, or the use of aqueous acriflavine packs.

5. Carefully *pack* the wound with soft gauze soaked with liquid paraffin and containing a little B.I.P.P. Insistence must be placed on the tightness of the packing and that it reach to the bottom of the wound. A dead space behind the packing is likely to persist as a focus of infection. Here the pack acts not as a drain but as a plug.

6. Apply dry gauze dressings and bandage. Secure adequate rest of the part by plaster or other methods of splinting.

7. Watch the patient. In general, there is an early relief from pain. Moderate fever for three days is not alarming. Severe pain, persistence of high temperature for a longer period or toxic symptoms demand investigation.

8. If oozing through the dressing occurs, pour on a little alcohol and reinforce the dressing.

9. Dress in six days to three or four weeks, usually under anesthesia, especially for the first dressing. The importance of keeping watery solutions away from these wounds must again be stressed. Secondary infection will nearly always result. The use of hydrogen peroxide is particularly to be avoided, and similarly Dakin's solution and other tissue solvents. The reason for the sudden flare-up of infection in the wound after the use of these materials is possibly due to the destruction of protective thrombi in lymph and blood vessels.

The question of "curtain drainage" has been referred to and may need some explanation. The principle is best demonstrated by pouring some water on a piece of glass and noting how smoothly the glass is covered. Let us now take another clean piece of glass and pour on it some oil. Even if the oil is wiped away, it will be found that a thin coating still adheres to the glass and the water cannot cover it smoothly. This same reaction occurs in the application of liquid paraffin to wounds in the tissues. If the wound is carefully dried and dehydrated so that close application of the liquid paraffin to the tissue is insured, and if, in addition, the wound is tightly packed *to the bottom*, the small amount of blood or serum will reach the skin surface along the curtain of liquid paraffin which exists between the tissues and the gauze packing. It is to be noted that the oil used must be a nonabsorbable mineral oil.

The formula of B.I.P.P. and its preparation deserve some attention. The paste is composed of one part bismuth subnitrate with two parts of iodoform (powder) and sufficient liquid paraffin to form a paste. Stress must be placed on the use of liquid paraffin and not vaseline. The use of vaseline will result in a greasy ointment which will not adhere to the tissues.

The arguments advanced against the use of B.I.P.P. are many and varied. One of the most common is that it is impossible to sterilize any wound by chemical methods without serious damage to the tissues. Hence, certain surgeons have developed an almost fanatical prejudice against "putting chemicals into wounds." We would like our names to be associated with a campaign against a probably greater danger of "putting water into wounds," and this includes the injection of local anesthetics. In this connection, I would like to call your attention to the statement by no less an authority than Dr. William Darrach, who in a recent paper made the following statement, having special reference to compound fractures: "The wound itself and any exposed tissue should be greatly washed with saline solution, care being taken not to allow the fluid to enter the deeper planes."

In regard to preoperative care of wounds in general, we have always believed that the mechanical cleansing of wounds was, if possible, much better accomplished by other means than by the washing of wounds with watery solutions which must of necessity carry into the wound itself the ever present bacterial flora of the skin. We have no fear of the frequently mentioned danger of tissue necrosis by the application of alcohol to wound surfaces. We have never believed that this matter was of any great importance nor have we ever seen any ill results from its use. We would like to point out that none of the advocates of the B.I.P.P. treatment have ever claimed that wounds were sterilized by this method and we are quite prepared to admit that no wound can be sterilized by chemical means. We do claim, however, that this material has certain very positive actions. These are:

1. Inhibition of bacterial growth.
2. The liberation of small amounts of iodine over a long period. This action was shown many years ago to be due to the liberation of iodine by the oxygen in the wound and in the blood stream. It has also been proven that there is a liberation of a small amount of nitric acid by hydrolysis of the bismuth subnitrate. Iodine has been recovered daily from the urine for as long as three weeks after the application of B.I.P.P. to a wound.

The work of Anderson, Chambers and Goldsmith, in 1917, has never been disproven, while evidence, both clinical and laboratory, has many times confirmed their findings. While wounds treated in this manner are not free from bacteria, they show a marked reduction in the bacterial count and those present do not seem to be able to

proliferate freely. There seems to be a definite stimulation of the bodily resistance of the individual which enables the wound to heal frequently as if it never had been infected. In other words, there is very little doubt that this method of treatment enables the bodily resistance to be markedly raised. As there is almost invariably a large amount of serum thrown out along the layer of liquid paraffin "curtain drainage," we have always inclined to the belief that the wound was stimulated to pour out increased amounts of serum and that this lymphorrhea had the effect of washing bacteria from the wound and that it also increases the available supply of whatever immune bodies—alexin and other—the body fluids contain. One thing is certain, there is undoubtedly an extremely early formation of healthy granulation tissue, of which the character, color and general behavior toward healing are very distinctive.

As an indication of the importance that this method of treatment is once more assuming, it may be noted that in a recent Hunterian lecture before the Royal College of Surgeons of England, Mr. James H. Saint reviewed the B.I.P.P. method of treatment of acute osteitis. Mr. Saint calls attention to the so-called Winnett-Orr method and its similarity to the B.I.P.P. method. We believe his paragraph on this subject is worthy of quotation:

"This is placed under a separate heading because, owing to Orr's publications (1927) it has become known by his name and seems to have been accorded the status of one which apparently differs from any other. Since, however, it consists of the gutter operation, the treatment of the wound with alcohol followed by iodine, the packing of the wound with vaselined gauze, and the immobilisation of the affected part, its similarity to the B.I.P.P. method of treatment becomes at once apparent. At the time, towards the end of the late war, when Orr was formulating his method of treatment, the B.I.P.P. method was already established and widely practised in the British Armies. While the principles of this method are the same as those governing the B.I.P.P. method—namely, the removal of the bony focus of infection, the use of an antiseptic and immobilisation, and it has the same advantage of obviating the necessity for frequent dressings—yet it is different in one or two important details. In the first place, the iodine as used by Orr will be absorbed in a very short time and no further supply will be available under his method of treatment. The use of B.I.P.P., on the other hand, results in a continuous supply of nascent iodine to the tissues as long as the paste is present in the wound."

In confirmation of the statement made above, we think it is fair to state that both the authors of this paper had personal experience with the use of the B.I.P.P. method during the latter part of 1916, and that one of us (F. B. G.) published in 1918 an article which was based upon a study of wound healing in a large number of cases of osteitis treated by different methods and in which the employment of B.I.P.P. and liquid paraffin soaked gauze packs was recommended. Perhaps the most impressive difference between wounds treated by vaseline gauze packing and liquid paraffin soaked gauze plus B.I.P.P. is the comparative absence of odor in the latter even after many weeks.

TOXIC SYMPTOMS

During the twenty-one years since the close of the first phase of the war, although we have in the "L" service of The Montreal General Hospital used the B.I.P.P. method in the treatment of thousands of wounds, both traumatic and infective, we have yet to see an important case of either iodoform or bismuth poisoning in a patient so treated. We have, however, seen a moderate number of cases which have exhibited a bismuth line on the gums but without further evidence of poisoning. During the years 1917 and 1918 a few wounded soldiers did die of bismuth poisoning. The lesions found at autopsy in their cases consisted of a metallic stomatitis with necrosis of the mandible and an extensive ulcerative colitis. Fortunately, it is true that a superficial stomatitis or gingivitis antedates the development of serious lesions by several days and opportunity is thus given to remove all of the paste before dangerous symptoms ensue. To the best of our knowledge, neither of us has ever seen a fatal case of iodoform poisoning.

USES IN VARIOUS TYPES OF WOUNDS

We believe B.I.P.P. may be safely and effectively used for the following types of wounds:

1. Acute traumatic lesions whether due to gunshot wounds, automobile injuries or construction accidents associated with potential infection and with particular reference to compound fractures. In the less severe types of wounds of this sort we may occasionally do a complete primary closure. We believe, however, that a delayed primary closure is nearly always advisable. This adds a considerable factor of safety and very little time is lost. When the loss of tissue has been great so that delayed primary suture is impossible or

when there is moderate infection, we use secondary suture or make use of various plastic procedures for filling the defects.

2. Infected wounds. These may be the results of untreated trauma or infection of operating wounds.

3. As a prophylactic measure against the infection of the body wall in the opening of certain infected cavities, notably, (a) abdominal abscesses—appendiceal or otherwise; (b) empyema or lung abscesses; and (c) operations on the mastoid or other deep seated abscesses.

SUMMARY

1. This paper is presented to bring attention to a valuable method of wound treatment.

2. A detailed technic is given.

3. A thorough understanding and careful application of the principles of this technic is necessary.

4. More than twenty-three years experience in military and civilian surgery have served to confirm the authors of this article as to the value and safety of this method.

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DISCUSSION OF PAPERS OF DR. KREUSCHER AND DRS. FRASER B.
GURD AND LAURIE H. MCKIM

ROBERT L. RHODES (Augusta, Ga.): Speaking first of Dr. McKim's paper, I want to express my appreciation of hearing it. I have had no experience with Bipp and therefore am not qualified to discuss it, but I think we can find some use after hearing that particular paper. I want to thank him for bringing it in such detail to our attention.

In regard to Dr. Kreuseher's paper, I may say he beat me to a place on the program. I submitted a title, "Twenty Years' Experience with Chloramine-T." I am glad he did beat me because he expressed my thoughts and ideas infinitely more effectively than I could, and I can only say "Amen" to everything that he has said.

I wish to remind you of one thing. If we recall, soon after Dakin's solution was first worked out, Dakin showed that there was a rapid fall of chlorine after the wound was flushed, a drop almost to the base line, then a second rise, which required over two hours to expend itself. That secondary rise occurred so often that he began an investigation as to why it was, and found that it was due to a definite chemical compound having been formed to which he gave the name ehloramine-T, not diehloramine-T. That is another product, soluble in oil. Chloramine-T is water soluble. That was brought out in 1916. In this country the Abbott Laboratories, in Chicago, presented it first to the medical profession under the trade name of Chlorazene, and they are still making it.

Incidentally, a very prominent industrial surgeon recently made the statement that ehloramines had fallen "into relative disuse." I checked upon this and the Abbott people themselves sold over a quarter of a million pounds of ehloramine-T products during the last year, so it evidently has not fallen into disuse, and they are only one of several makers.

The advantage of chloramine-T over hypochlorites, or true Dakin's solution in which the margin of antiseptic factor as shown by Dakin was 0.05 per cent (between 0.45 and 0.5 is the correct amount of sodium hypochlorite concentration), is its prolonged effect even as it is being gradually diluted in the wound.

He showed that chloramine-T has all the effects of true Dakin's solution save one, and that is that it does not have the property of dissolving necrotic material and they changed to chloramine-T after all necrotic matter was removed. It is stable, nonirritating and germicidal over a prolonged period. I have tested it in dilutions as far as one to five thousand and found very definite bactericidal effects.

It was first introduced, as I said, under the name Chlorazene. It was accepted by the Council on Pharmacy and Chemistry and included in the U. S. Pharmacopoeia under the name of chloramine-T.

I am bringing out those points because the market in the last several years has been flooded with proprietary or patented preparations which more or less are the same thing or are strikingly similar to U. S. P. chloramine-T but cost appreciably more.

Our experience with the use of chloramine-T over a period of twenty years is so strikingly analogous to what has been brought out, that I need not repeat that at all. But let us not overlook the fact that "chemical sterilization" is third in the steps of handling wounds and was so recognized in the "Carrell Dakin Treatment" preceded by "mechanical cleansing" and "surgical cleansing" (debridement). These two should carry 95 per cent of the burden and leave only about 5 per cent to "chemical sterilization." In industry and accidents generally today there is no excuse for the delay of the injured in reaching the surgeon as existed in the World War.

I recently sent to the members of the Association for the Surgery of Trauma three reprints, with two thoughts in mind: First, as a discussion of two of the papers presented last year, and incidentally they happen to be a discussion of this particular paper this morning; but primarily for this reason: to show to the members of this Association what we in Georgia are trying to do through the State Medical Association in bringing these problems to the general practitioner. The one relative to compound fractures was part of a symposium on fractures presented by the State Fracture Committee of the American College of Surgeons, covering the subject of fractures. The other was presented by the Georgia State Industrial Surgeons Association. The aim was to try to educate the doctor at large in the handling of these injuries, or in the getting of the injured into the hands of somebody competent to handle them, rather than, as so often happens, sending them in dabbled and smeared up with various irritants and in infinitely worse condition than they were at the time of the original injury. It seems to me that one of our functions should be, after we have thrashed things out, to take the results back to our State Associations and present them there with the emphasis of the Stamp of Approval by this Association.

W. L. ESTES, JR. (Bethlehem, Pa.): I believe that these papers have been most timely and valuable.

I believe we would all be in agreement concerning the general principles under which fresh wounds should be treated; namely, (1) control of hemorrhage, (2) prevention of any further contamination of the wound, (3) thorough gentle mechanical cleansing of the wound, preferably with soap and water and saline, (4) enlargement of the wound, if necessary, so that all parts may be completely visualized, (5) very gentle handling of tissues to prevent further trauma, (6) removal of all foreign bodies and débris, (7) débridement—the careful, thorough, and complete removal of all devitalized tissue (which Dr. Kreuscher so well emphasized), (8) accurate hemostasis with fine ligatures, (9) closure of wound—primary or delayed, (10) drainage, and (11) immobilization of part.

Furthermore, it is not only what is done, but also how it is accomplished, how thorough and painstaking these methods are pursued, that determines the success of the end result, namely, primary healing and a clean wound. However, I believe that we cannot safely apply a blanket treatment for all types of wounds. Wounds, as it is so well recognized in many other surgical lesions, must be individualized. The type of contamination and the severity of muscle and bone damage, particularly, call for variation in treatment.

It was a great step forward to have demonstrated that with thorough mechanical cleansing of a wound and the removal of all devitalized tissue, no antiseptic was needed to prevent infection; as normal living healthy tissue in itself is adequate to prevent infection of the wound when all possible nidus for growth of bacteria has been removed. Many antiseptics are tissue irritants and tend to delay healing because of their destructive action on healthy tissue.

However, the question was raised in a discussion last year on this same subject before this Association, as to the advisability of the use of an added safeguard, especially in the soil or anaerobically contaminated wounds with their particularly virulent bacteria, such as gas and tetanus bacilli; i.e., the use of some nonirritating but effective antiseptic in addition to the routine measures for treatment of wounds.

I think those of us who are dealing frequently with industrial wounds will recognize the difference with which we can regard an industrially acquired wound and that from an agricultural or soil environment as far as the type of contamination is concerned. Certainly we expect to find in the industrial wound much less serious contamination than in the soil contaminated wound.

It was suggested that Dakin's solution was a satisfactory antiseptic for use in these severely contaminated wounds and a small series of cases was reported in which it had proved effective without apparently causing any delay in healing. We have continued its use this year and find we have used Dakin's solution in about 40 per cent of the wounds presented to us for treatment in the last year. I do not think that this is necessarily a cross-section of what we would routinely or actually use, every year, year in and year out. The use of an antiseptic must depend on the type of wounds submitted for treatment and upon the judgment of the surgeon as to what treatment each particular type of wound requires.

With an extensive laceration of muscles, particularly with an open or compound fracture, delayed closure of the wound and effective immobilization are imperative. After cleansing and débridement the wound may be packed with vaseline gauze, liquid paraffin, or Bipp paste, according to individual preference. Dr. McKim has emphasized the indications for the use of Bipp paste. That long immobilization in these cases, without dressings or with but few dressings will permit more satisfactory and rapid

healing was Orr's particular and important contribution. Carrel-Dakinization of the wound may well be an alternative method, or, as has recently been suggested, sulfanilamide locally in the wound may be effective.

Those whose experience or contacts have made them partial to a certain method may find it renders them particularly skillful in its application, and satisfactory results with it will be obtained. It seems to me, therefore, that we should have at our command not simply a routine treatment to be applied to each fresh wound, but also certain variations in treatment which will best answer the problem that each particular wound presents. Indications for their use may differ, but that method should be applied to each wound which will obtain the best results.

These two papers have been important in demonstrating at least two optional methods that are worthy of consideration when attempting to solve the problem of the treatment of a fresh wound.

R. ARNOLD GRISWOLD (Louisville, Ky.): In discussing these two very excellent papers, I should like to express my belief that it is a relatively small proportion of wounds in which it is necessary to carry out this type of treatment. In the type of wounds under consideration, that is, ordinary street and industrial wounds, at least 95 per cent can be closed primarily and will heal without infection. In the other 5 per cent these methods, Bipp, vascline gauze, or Dakin's solution are necessary. This 5 per cent includes wounds over eight hours old or those in which the surgeon's judgment, on account of excessive contamination or massive destruction of soft tissues, primary closure is not advisable.

We all agree, I think on the principles of the primary care of these wounds, thorough cleaning and removal of all foreign bodies, whether they consist of dirt, blood clot or devitalized tissue. But we do disagree on the details of this débridement and cleansing proposition. This is not a procedure to be carried out in fifteen or twenty minutes in the office or accident room. Proper cleansing of a major wound is a major operation which should be carried out with all the ritual and technic of a gallbladder or thyroid operation. All foreign bodies, whether they be dead tissue, blood clot or dirt must be removed. Hemostasis must be obtained. For arterial hemostasis it may be necessary to use a few fine silk ligatures, but venous bleeding can be controlled by pressure in most instances.

I have never been afraid to put aqueous solutions in a wound, since the body fluids themselves are aqueous, but in putting them in they should flow from the inside of the wound to the outside and they should not be put in with a pitcher or by squeezing out a sponge but with a hose and nozzle. The nozzle should be put in deep and the flow of the irrigating saline should be out and away from the depths of the wound, using Henry Marble's galvanized iron pan to catch the flow.

No sutures are used beneath the skin except for nerves and tendons, that is, no layer suturing of fascia and muscle. Nerves and tendons may

be approximated with a few fine silk sutures and the skin closed only with interrupted silk.

I think if this cleansing procedure is faithfully and meticulously carried out in the way that neurological surgeons carry it out, these wounds will heal primarily without being packed open or irrigated.

This procedure can be carried out successfully not only by one who is enthusiastic about it, but by the ordinary hospital house staff as illustrated by a case seen recently. This patient was driving with his whole hand and arm out of the car window when side-swiped by a truck. He apparently attempted to straight-arm the truck and his hand was driven backward on the forearm, the distal end of the radius coming out the palm of his hand. About one and one-half inches of radius was left on the roadside. There also was a compound fracture of the ulna and metacarpals and a few phalanges and irregular lacerated wounds from the base of the fingers half-way up the forearm. An assistant resident, two years on the surgical service, cleaned up this arm did his débridement and irrigation and closed the wounds tight. At the end of ten days the patient was fever free, the temperature never having gone over 100°F. The wound healed by primary intention without any packing, open or Dakin irrigations.

Therefore, I believe that with proper surgical judgment 95 per cent of the type of wounds which we have under consideration here can be closed primarily and get a better end result than healing by secondary intention with the increased amount of sear that secondary healing brings with it.

CLAY RAY MURRAY (New York City): I am afraid I cannot let what Dr. Griswold said about these papers go by without offering some objections.

Before I discuss what he had to say and, incidentally, what the papers had to say, I should like to emphasize one point in the treatment of wounds, particularly important in compound fractures, which has not been emphasized very strongly. That is the question of the speed with which the patient is gotten from the accident to the operating room. I think that probably, all factors considered, this is the most important factor in deciding whether a wound is going to become infected or is going to heal cleanly, regardless of the method of treatment. I think delay in treatment of the wounds in compound fractures is more often responsible for infection than is the type of treatment the wound is accorded.

In my own hospital, after a campaign of twelve years, we have reached the point where a compound fracture has precedence over all other emergencies in the operating room. I think this is a proper attitude. I think this point needs to be emphasized very strongly. The initiation of the treatment in wounds, particularly compound fracture wounds, should be estimated in *minutes* from the time of accident and not in *hours* from the time of accident. I think that the difference between an hour and three hours is a tremendous factor in deciding whether under any method of treatment the wound is or is not to become infected.

Secondly, I approve very thoroughly of the principles which were enunciated in the Bipp method of treatment for compound wounds. One must admit that if you exercise good surgical judgment in a majority of wounds you can close them and "get away" with it.

I do not believe in boasting about what you can "get away" with. I know—I don't "think"—I know that in the 5 per cent, even, that Dr. Griswold is willing to admit you do not "get away" with, when they develop infection it represents frequently a major disaster.

Jack Connor, some years ago, at Harlem Hospital, ran two series of cases, one hundred cases each, of compound wounds, all of which in the judgment of the operator, could be closed primarily. In the first hundred cases the wounds were so closed, after adequate débridement; conditions were identical for the second series except that no primary closure was done.

In the first series, with the wound closed primarily, seven infections developed out of the hundred; in the second series of cases with wounds left open and closed secondarily with delayed suture, eight infections developed one more than in the closed wounds. Of the seven infections developed in the closed cases, one patient died of septicemia, amputation was carried out in two cases and every patient except one developed osteomyelitis. In the eight cases left open and therefore not under tension, there wasn't a single case of sepsis, no amputation, and only one osteomyelitis.

I think the question is not whether you can "get away" with a wound open or closed in the majority of cases. The question is what happens when you do not "get away" with it. I have never been able to understand why a wound healed by secondary intention in a compound fracture is a distressing thing for the doctor or the patient. I do not believe the healing by secondary closure is any defect in treatment at all. I refuse to bet my judgment against the patient's leg even though the odds on the bet seem excellent. When he loses, the patient's loss is out of all proportion to what he has to gain, which is a week or two or three of extra hospitalization. I, therefore, do not believe that a compound fracture should be closed primarily.

I will admit it can be done and you can "get away" with it usually. I do not believe that a wound in which sutures are placed at the time of operation, with the wound closed by tying these sutures at the end of five days, delays the patient's convalescence materially or gives poorer results. I know it is a much safer procedure.

E. T. CROSSAN (Philadelphia, Pa.): In 1919, Sir Almroth Wright made the statement that if there was any antiseptic that cleared up infection, that fact deserved to be broadcast with headlines in all the newspapers. He was referring particularly to the Bipp method and the Carrel-Dakin treatment.

These papers recall experiences because during the World War I had under my care at times about one hundred patients on the Carrel-Dakin method of treatment, and it was supervised by disciples of Carrel and Dakin, taught at their institution and of course it was handled with most meticulous care; yet my memories are in agreement with what Sir Almroth Wright said would happen. In spite of the method those patients were dressed day after day and the pus poured out for weeks. To Sir Almroth Wright there was nothing disheartening in those failures for he proved that when Dakin solution or Bipp paste was introduced into a wound, within a few moments the antiseptic was so diluted by the wound fluids, that it was no longer lethal for the bacteria.

Since hearing these papers, maybe I should have resumed the use of the Carrel-Dakin method. I discarded it after I left the service, and I have not used it since, because my results, too, have been satisfactory, and they have been satisfactory without antiseptics and without scrubbing the wound at all. We make no attempt to scrub or shave a wound. We think you cannot do it without contaminating a wound. Perhaps it is the locality that we are in that is responsible for our getting good results in this movement.

I have only seen two cases of gas gangrene in twenty years, and I have a big service in a big city hospital. Because of my luck I had been closing all compound wounds and closing them up until one time there was a discussion between the Philadelphia Academy of Surgery and the New York Surgical Society, at which time Dr. Beekman took me for a ride because I was closing these wounds, and said, "What would you do if it was your leg?"

Well, I know what I would do. I would fear I might be among the 5 per cent Dr. Griswold spoke of, and I would be afraid I might lose my leg; so you can guess the treatment I would want.

I want to emphasize regarding the treatment of wounds something that has not been mentioned at all and something I find the magazines speak very casually about; that is, the subject of tetanus. No mention of it has been made. It is assumed that one prophylactic dose will do, but one is not sufficient. I have just had on my service a second case of tetanus in two years in spite of the fact that the patient had a prophylactic tetanus antitoxin.

I want to emphasize that it seems to me the good results obtained are due to the care with which we are handling the wound and not to what we use in the wound.

FENWICK BEEKMAN (New York City): I do not wish to prolong this discussion, but Dr. Crossan, I think, has brought me in and put me on the spot. We, in New York, have gas gangrene. Apparently that discussion we had in Philadelphia some ten years ago has stuck. They do not have gas gangrene down there.

Since that time I think all of us have changed our views on the treatment of wounds. I, for one, have done away with antiseptic treatment of wounds. I have been laying a great deal of stress recently on the complete immobilization after the preparation of my wound; and, by "preparation of my wound" I mean what has been described here, preparing the wound for further treatment, that is, your débridement and cleaning up, which I agree with entirely.

The question of closure of the wound, or the secondary closure of the wound, depends upon the experience of the surgeon, the case under consideration and his judgment in that case.

In a compound fracture of the skull I think all of us could do a primary closure, but where there is a compound fracture of the tibia, I think that I agree with Dr. Murray. I think it is safer for the individual to do a secondary closure.

I have carried the immobilization of wounds much further than most people have. We get on the Children's Surgical Service at Bellevue a large number of avulsions of the skin of the limbs, where the skin and subcutaneous tissue are entirely torn off, leaving the muscles exposed. We take those children to the operating room and prepare them, and then we put them in complete immobilization, and when I say "complete immobilization," I mean we put them in a plaster cast. For instance, the leg, if there is an avulsion around the knee, we put a plaster cast on from the toes and continue it right up to the chest as a spica. I think we have not laid enough stress today on rest.

I remember when I was a student, J. William White used to tell us that rest was most important. We did not know what rest was in those days, but since the day when Orr first came out with his ideas on the treatment of compound fractures, which none of us agreed with at the time, some of us have carried the method further than he had, and I am using immobilization in all my severe wounds in an active traumatic service.

GROVER C. WEIL (Pittsburgh, Pa.): I am very sorry I came into the meeting a little late but in view of the importance of the subject, I feel that I should at least report a method we are using at the present time, in fact, for the past year.

It has been our belief in reference to compound fractures—I come from an industrial community where contamination of wounds is quite heavy—that we have always adhered to the open method, long before Orr popularized the idea, immobilization, fixation and, of course, packing the wounds.

Our preliminary cultures have always shown essential contamination with gas bacillus and staphylococcus, and the various staphylococcic forms and in a large industrial service, from the point of view of economy and safety to the patient and eventual return of function, it has always proved in our hands the most efficient method.

Of recent date we have been using sulfathiazole; at first sulfanilamide, then sulfamethythiazole, and since its discontinuance, we have been using

sulfathiazole. The extent of the experience to date, of course, is too small, even though we have had over a hundred cases; nevertheless, it deserves a tryout, but I think the results obtained by introducing the powder immediately into the wound and then following with fixation and immobilization, is well worth while in reciting our experience.

The results obtained to date have been perfectly marvelous in those cases in which we have used sulfathiazole, depending upon the size of the wound as to the amount to be introduced. We implant and use the powder throughout the entire wound and also administer it by mouth. Our previous low cultures always showed potential contamination. The use of this method has permitted us to close our wounds to a point now at which we believe it can be done with safety, shortening the period of convalescence and permitting the healing of the wound and unionization without interference of infection. That is the thing we desire, the prevention of infection and the unionization of wounds.

We also have deep respect for a therapeutic dose of gas bacillus antitoxin, and we do not forget the possibility of tetanus.

PHILIP H. KREUSCHER (closing): I wish to thank the men for their discussion of this paper. It is only the difference of opinion which makes a discussion possible and profitable.

When selecting a method of treatment for any given condition, one must first have faith in the method and enthusiasm concerning it and not simply use a certain method or preparation because some one has suggested it. Every method of treatment must be molded in the hands of the surgeon who is going to use it and must have as its purpose the best interest of the patient.

In these industrial wounds our primary aim is to get them to heal with the least amount of scar tissue, the least morbidity and the least disability.

A number of years ago when I took up my work with the steel corporation I decided upon this method and believed that it should be used for a period of years until results could be evaluated. In these three and one-half years we have had results that are completely and entirely satisfactory, and we are going to stand on our record of three infections in 26,000 wounds.

LAURIE H. McKIM (closing): May I thank those who have discussed this paper for their very kindly remarks. I may say we are possibly slightly disappointed that we did not draw a little more fire. However, that will probably come.

I want to refer just to one or two things: I am afraid I cannot agree with Dr. Griswold that 95 per cent of the wounds can be closed with safety. Certain of my friends have believed in that doctrine and the thing has not worked. I agree very strongly with what Dr. Murray has said about the time between the injury and the treatment of wounds, especially compound fractures, and, believe me, in any hospital where that principle is disregarded, the results will be correspondingly bad.

Dr. Crossan has mentioned the second dose of A.T.S. There is no doubt whatever about its value, in my mind, and I have always practiced it since the War.

In regard to the occurrence of gas gangrene and tetanus, I purposely did not mention them because I felt they might be covered in the other paper and in any case it would be better to take them up separately. The subject is much too wide for such a brief consideration.

We do have in Montreal considerable tetanus and a fairly large amount of gas gangrene. Last year I had under my care three cases of gas gangrene at one time. I am glad to say that none of these had been primarily treated by me. One occurred in a man with a diabetic toe.

As to the question of the various chemicals such as sulfanilamide, I have had very little experience with their use directly in wounds.

I think this covers practically everything I have to say in order to bring the discussion to a close.

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Note: Dr. James C. Magee, Surgeon General of the U. S. Army, also gave an address at the Meeting of The American Association for the Surgery of Trauma in Atlantic City, June, 1940.

FIFTEEN YEARS OF THE TANNIC ACID METHOD OF BURN TREATMENT*

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IN spite of the fact that the tannic acid method of treatment of burns advocated by Davidson in 1925¹ has virtually revolutionized the treatment of burns throughout the world, the method has received much unfavorable criticism. It may be in order, therefore, for those of us who have had an unusual opportunity to study the method to present the data which we have accumulated during the past fifteen years.

In previous communications,^{2,3} we have outlined the method of treatment in detail and have analyzed the statistical data that were then available. In the present discussion we shall attempt to evaluate our own experiences and those of others as recorded in the literature as they tend to answer the question, "Is the tannic acid routine the most satisfactory method of burn treatment at present available?" At the same time, we shall consider the various modifications of the coagulation routine as they appear to affect the results. It seems reasonable to discuss as a part of the tannic routine various procedures that have been developed subsequent to Davidson's work, since it was his conception of the problem which stimulated the studies that have lead to many variations of the coagulation method.

One of us had been working on the burn assignment at St. Luke's Hospital for several years prior to 1925 and had been using with considerable enthusiasm the "Ambrine"⁴ (paraffine spray) method which had been adopted following the War. Prior to that we had used exposure to dry heat under a cradle, baths of warm solution and various oils and ointments. It was with some reluctance that we tried the coagulation method of Davidson in 1925, but after a few weeks we began to be impressed with the following observations: (1) that the patients so treated were more comfortable, requiring very little sedative; (2) that they were much easier to care for; (3) that they did not seem as ill as those treated by other methods.

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The final answer to the effectiveness of primary treatment of burns rests with the mortality rate. Unfortunately, not many critical studies of the effect of the coagulation method upon mortality have been made upon large numbers of patients, and large numbers are necessary to minimize error. Burns do not, moreover, lend themselves to statistical study. It is impossible to compare accurately burns as to surface involved (even using the method of Berkow)³ and the depth of the burn may be a matter only of conjecture by the most experienced observer. Furthermore, the severity of burns varies from year to year in any community, and the criteria for admission to hospitals may vary similarly.

Table 1 shows the mortality trend with tannic acid and other methods of treatment collected from the literature. Practically all observers who have attempted to compare their results statistically have reported a significant decrease in mortality with the coagulation method.

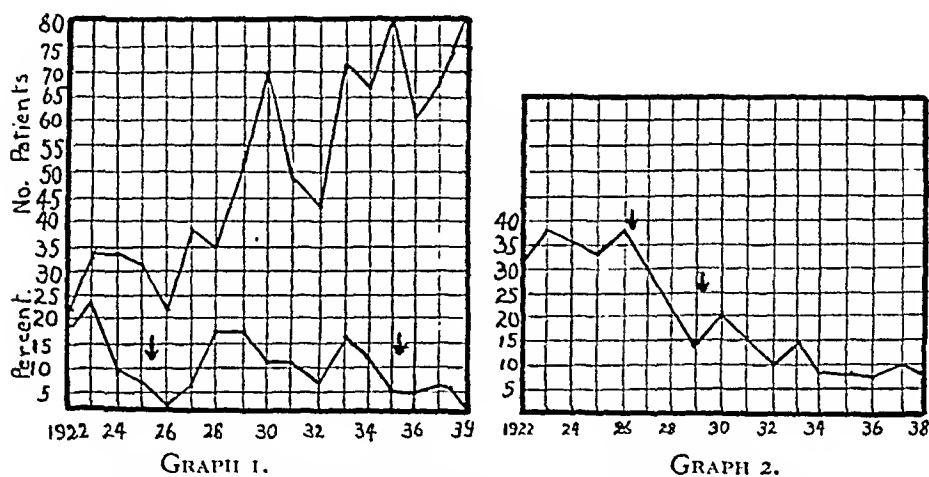
TABLE 1
TREATMENT OF BURNS
Comparative Mortality with Tannic Acid and Other Methods

Author	Other Methods		Tannic Acid	
	No. of Patients	Mortality Per Cent	No. of Patients	Mortality Per Cent
Baneroft and Rogers (New York) ⁴	90	40.0	114	20.0
Beckman (New York) ⁷	320	37.8	114	14.9
Wilson (Edinboro) ⁸	300	38.7	117	11.1
Harris (Toronto) ⁹	....	26.6	....	12.0
Mason (Phila.) ¹²	91	28.5	87	13.3
Langer (Vienna) ¹⁰	86	16.3	65	7.7
Mitchiner (London) ¹¹	243	9.4	249	2.4
McClure and Allen (Detroit) ¹²	118	9.3	358	11.7
Glover (Cleveland)	121	14.0	809	8.4
Total patients....	1369	....	1913	....
Average mortality . .		24.5	...	11.3

From these figures it would appear that if the patients in the tannic acid group had been treated by other methods, 252 would have died who actually survived.

In the figures quoted from our own series, we have used the same criteria throughout the entire interval of nineteen years before and after the use of tannic acid. The indications for admission of patients with burns to the service have remained the same throughout except that in all probability there has been a tendency to hospitalize more

burns in the later years of the series than in the earlier years, as physicians have become educated to the efficacy of hospital treatment. Generally speaking, all burns of sufficient extent to constitute



GRAPHS 1 AND 2. The mortality trend by years. In Graph 1 the upper curve represents the number of burn patients. The lower line indicates the mortality rate by years. The first arrow indicates the beginning of the tannic acid routine. The second arrow indicates the addition of silver nitrate to the routine. In Graph 2, the interval between the arrows indicates the use of tannic acid experimentally, but subsequent to the second arrow it was used routinely. Graph 1 is from the authors' series, Graph 2 from the series of Penberthy and Weller, Detroit.¹⁴

any hazard to the life of the patient or that presented any difficulties in treatment were admitted. Burns of the eye, minor chemical burns, hot water-bottle burns and others that were complications of hospital treatment were excluded, as were those which were incidental to another injury necessitating hospitalization.

Particularly significant is the mortality trend by years from the beginning of the series in 1922 to 1939. The decline in mortality since the beginning of the coagulation regime seems too impressive to be discounted. Comparison of our Graph 1 with that of Penberthy and Weller¹⁴ in Graph 2 shows a similar trend.

Study of the deaths in the series is productive of significant data. It was shown by Beckman⁷ and one of the authors² previously that the late deaths following burns were relatively fewer than with other methods of treatment. In other words, the chief reduction in mortality rate in the tannic acid series comes after the first twenty-four hours.

Table 11 shows the causes of death in our St. Luke's Hospital series. It will be noted that the major number of deaths are attributed to the toxic period during the first three days following the

burn. (This includes the periods of "primary shock," "secondary shock" and "toxemia" of Wilson;¹⁶ but the latter would probably include the deaths we have classified as late toxic and cardiac collapse within the interval of "toxemia.")

Over one-half of all the deaths occurred during the first twenty-four hours. Of our mortality rate of 8.4 per cent for the series, over 4.2 per cent of deaths occurred on the first day following the burn, due to overwhelming injury. We believe it is significant that the mortality rate during the first twenty-four hours has not been greatly altered by any method of treatment. (We reported previously

TABLE II
TREATMENT OF BURNS
St. Luke's Hospital Series
Patients 809 Deaths 68 Mortality 8.4 Per Cent

Causes of Death	Deaths	
	No.	Per Cent
Toxic. (This includes all patients who died due to the effects of the burn within the first seventy-two hours. It includes deaths that would be classified by others as due to "shock." In two instances hemorrhage into the intestinal tract may have contributed.) Three-fourths of these deaths occurred in the first twenty-four hours	44	64.7
Delayed toxic and cardiac collapse (fourth to seventh days)	14	20.6
Thromboses and pulmonary emboli	4	5.8
Late vascular and cardiorenal complications	3	4.4
Hemorrhage from Curling's ulcer	2	3.0
Suicide	1	1.5
	68	100.0

a similar rate for the series without tannic acid.) It is, therefore, in the later days of treatment that we must look for reduction in our mortality rate. It will be noted in our series there were no late deaths due to infectious complications. There were fourteen deaths due to a delayed toxic effect or sudden cardiac collapse between the fourth and the seventh days. Thrombophlebitis, pulmonary embolus, late vascular and cardiorenal complications and hemorrhage from Curling's ulcer made up a small percentage of the causes of death, and one patient committed suicide successfully in the hospital after setting fire to himself in the first place.

We believe that the coagulum serves the following important functions during the first few days following the burn: (1) It fixes the

protein in the burned tissue and prevents the hypothetical "*b*-substance" from being absorbed; (2) it prevents dehydration; (3) it prevents infection; and (4) it keeps the patient comfortable. If this conception be correct, the speed of coagulation is an important item, pointing the need for prompt treatment and the use of coagulants that will produce the quickest results.

TABLE III
TREATMENT OF BURNS
Comparison of Burn Deaths in Hospitals A and B
(Covering the interval from January 1, 1935, to December 31, 1939)

	Hospital A	Mortality Per Cent	Hospital B	Mortality Per Cent
Number of burn patients.....	362	...	227	
Number of burn deaths.....	16	...	31	
Gross mortality.....	...	4.4	...	13.6
Causes of Death				
Death during toxic period				
First 24 hours.....	10	...	13	
Second 24 hours.....	2	...	1	
Third 24 hours.....	2	...	1	
Total in toxic period.....	14	3.8	15	6.6
Late toxic and cardiac collapse.....	1	...	4	
Late infectious compl. (incl. pneumonia)...	0	...	10	
Late vascular compl. (incl. pul. embol.)...	1	...	1	
Late hemorrhage.....	0	...	1	
Total late deaths.....	2	0.6	16	7.0

Table III shows comparative results in two series of patients in Cleveland Hospitals during the same five-year interval, with early and late deaths tabulated.

In Hospital A, burns have been handled in a systematic manner, using the coagulation regime almost exclusively for fifteen years, and almost all patients were treated as emergencies and tanned promptly. In Hospital B, the clientele is of a poorer economic group with its greater physical handicaps which must contribute to mortality figures. But in this group also many of the burns were brought to the hospital late and more variations in methods of treatment were followed, although the majority were treated with tannic acid and silver nitrate. We believe that the delayed treatment and in some

cases ineffectual treatment contributed to the higher incidence of late deaths from infectious complications, especially pneumonia.

This brings us to a point where our experience has been at variance with that of Davidson, who believed that the coagulum should not be disturbed too early for fear of precipitating a secondary toxic response. Our experience leads us to believe that in all but the very superficial burns the coagulum no longer serves a useful function when it begins to separate and it should be removed in the most effective and expeditious manner. This is accomplished most effectively by continuous dressings of Dakin's solution. It is this particular stage of the treatment that has brought much criticism against the method because "infection develops under the crust."

From five to eight days after treatment is begun, the coagulum begins to separate from the surrounding skin edges exposing a gelatinous exudate. At the same time the center of the coagulum may begin to elevate and become fluctuant, and the patient's temperature goes up. (In superficial second degree burns the crust merely cracks off at about ten to fourteen days leaving intact epidermis while in deeper burns the process is much slower.) If at this stage continuous Dakin's solution dressings are applied (using an active and stable preparation), the temperature will go up to a sharp peak for a few hours; then it will drop down and remain at a level between 38 and 38.5°C. until the crust is all off and the granulating surface covers rapidly with epidermis, or until it is ready to graft. If instead, the surgeon vacillates between leaving the coagulum alone and getting it off, the patient becomes desperately ill, runs a septic temperature, develops a secondary anemia and all too often some infectious complication appears. It is in this stage that we see the most trouble among physicians who treat burns only occasionally.

While the crust is dry and tight, microscopic sections show it as a layer of dermis and sometimes subcutaneous tissue incorporated in a dense coagulum, with a narrow inflammatory zone beneath which lies normal tissue. This normal appearing underlying tissue may be grossly edematous before the tissue is dehydrated and fixed. The maximum local edema resulting from the burn is usually found between the second and the fifth day and begins to recede by the sixth or seventh day. As the tissue edema recedes, the coagulum cracks and buckles and in some areas "floats." The inflammatory zone widens and liquefies producing a gelatinous exudate which increases in amount, gradually floating off the eschar. Organisms may often be grown out of this gelatinous exudate, although unless

neglected the bacterial growth is not rapid. If the coagulum is left undisturbed at this stage, however, the patient runs a clinical course similar to that of an infected wound.

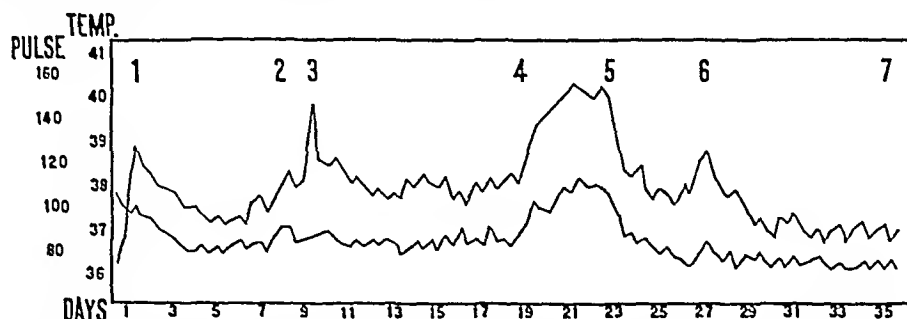


CHART 1. Typical temperature and pulse curve in a severe burn. 1, initial rise, followed by drop when surface is coagulated. 2, coagulum begins to separate. 3, Dakin's dressings started. 4, change to boric acid dressing. 5, back to Dakin's. 6, skin graft. 7, healed.

The Dakin's solution liquefies the gelatinous exudate, helps to break up the coagulum and inhibits bacterial growth. If the Dakin's solution is *not fresh* or is *not continuously in contact* with the surface of the wound, it does neither. We have previously described the details of management of this stage^{2,3} and will not repeat it here. The length of time required to separate the entire coagulum will vary from twenty-four hours to three weeks depending upon the depth of the burn. It is essential that the Dakin's solution be fresh and of proper hydrogen ion concentration. Referring again to the comparative Table III, it seems quite possible that some of the difficulty shown in the control of secondary infections has been due to Dakin's solution which is not consistently effective, a difficulty which has been recognized but not controlled in that institution.

Chart 1 illustrates graphically the clinical course of a severe burn and shows the reaction which results when an ineffectual type of dressing is substituted for Dakin's solution.

To recapitulate, we believe that the data herewith presented argue strongly in favor of Davidson's original hypothesis concerning the value of the tannic acid coagulum during the first days of burn treatment, but against his second hypothesis that to disturb the coagulum when it is beginning to separate incites a recurrence of the toxemia. While the coagulum may be life saving during the early days of treatment, it may be a menace during the later period.

ETIOLOGICAL FACTORS

Although experimental work has clarified some of the effects of severe burns, we are still unable to say what is the lethal factor.

The hypotheses concerning the cause of death may be grouped under the following headings: (1) physical; (2) toxic, and (3) infectious.

Underhill¹⁷ and his associates popularized the physical theory,

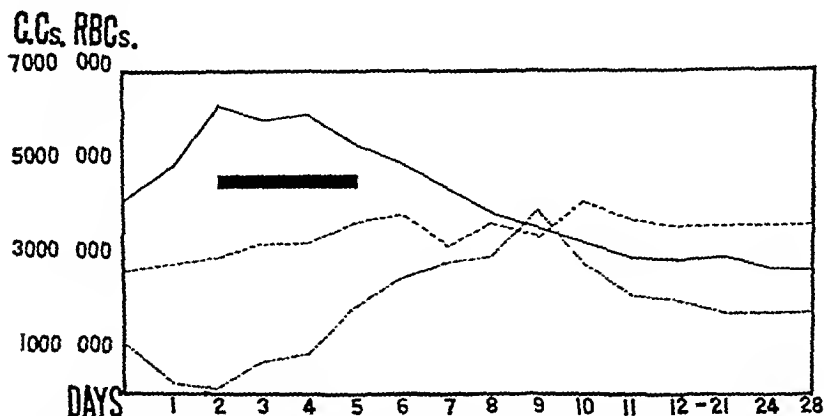


CHART II. Fluid balance in the severe burn. The solid line indicates the number of red blood cells; the dashes indicate fluid intake and the dots and dashes urine output. The solid block in black indicates the presence of albumin, casts and red cells in the urine.

assuming on the basis of their experimental data that the lethal effects of burns were due to blood concentration resulting from sudden displacement of fluid from the blood stream to the site of injury. There is ample experimental and clinical evidence^{16,18-20} that following the severe burn there is a marked increase in permeability of the capillaries at the site of the burn, resulting in rapid loss of fluid, plasma protein, chloride and sodium from the circulating blood. A shock-like state supervenes as well as blood concentration. It has not been possible, however, to produce liver necrosis, which appears to be typical of the burn effect, by other methods which will cause marked fluid and plasma displacement. From a clinical standpoint it is difficult to explain burn deaths upon the physical hypothesis alone. Some burned patients die without showing any shock-like phenomena and without manifesting any significant degree of blood concentration. During the stage of blood concentration and decreased urine output, furthermore, it is virtually impossible to combat effectively blood concentration by intravenous administration of physiologic solution of sodium chloride, dextrose, or by whole blood. Attempt to force fluids at this stage inevitably produces generalized edema. Chart II shows graphically the state of fluid balance in a severe burn. We have not had an opportunity to use plasma transfusions. On the basis of theoretical consideration

plasma transfusions should be ideal for replacing plasma proteins without increasing red cell concentration.

The toxic theory has also had many supporters. It has been assumed by several investigators that a histamine-like substance (sometimes called "*b*-substance"), perhaps a split protein, is liberated at the site of the burn.^{1,16,19} No such substance has been isolated, however. Recent studies suggest that potassium may be the mysterious "*b*-substance."³¹ The fact that the coagulation routine reduces the mortality from severe burns may be accepted as suggestive evidence in favor of the toxic theory. It has thus far been impossible to produce liver necrosis in animals by histamine alone, as may be produced by injection of blister fluid or edema fluid from the burned area. There is some inconclusive experimental and clinical evidence that individuals or animals may have their tolerance to the effects of burning increased by repeated exposure to similar injuries.

The infectious theory advanced by Aldrich²⁵ now has few proponents. It is almost inconceivable that the major number of burn deaths which occur during the first twenty-four hours could be caused by bacterial invasion.

THE COAGULATING AGENT

If we are correct in the premise that early coagulation of the wound influences mortality, it should follow that the more rapid the coagulation the more effective the treatment will be. Of all the coagulating combinations suggested thus far, tannic acid and silver nitrate produces the quickest results. By this combination a good coagulum is formed and is relatively painless in thirty minutes. It will be noted that in Graph 1 the mortality trend has dropped since the addition of silver nitrate to the tanning routine.

Seeger has called attention to the fact that the depth of the tanning process is influenced significantly by the hydrogen ion concentration of the tannic solution. He has advocated an isotonic formula for the tanning solution²⁸ which has been modified by Fantus and Dynewicz.²⁹ We have confirmed Seeger's observations that the rapid tanning with the ordinary 10 per cent tannic acid with low hydrogen ion concentration does not tan completely the deep third degree burns and that his slower method of tanning penetrates deeper. We have not followed enough cases using his method to be of significance statistically. Criticism and condemnation of tannic acid because it does not penetrate³⁰ to the depth of a third degree burn does not impress us as too serious an objection, since it is

common observation that the deep burns are already fairly well coagulated by the burn producing agent. It has been frequently observed, experimentally and clinically, that fire burns produce less local edema than hot water burns, which may reasonably be due to the greater degree of immediate coagulation by the flame. Critics³¹ of tannic acid have also stated that it destroys unburned epidermis in the process of coagulation. Admitting that this may be a fact (although we have failed to confirm it), if tannic acid saves lives while destroying a few epithelial cells, it is still a desirable method of treatment. We have seen no conclusive evidence that the coagulation method interferes with the healing process.

Ferric chloride was suggested by Coan³² as a desirable coagulent which produced a pliable crust. If used in aqueous solution, however, it is slow acting and if used in the more effective alcoholic solution, it is painful.

Gentian violet and subsequently a combination of dyes were originally suggested by Aldrich because of their bacteriocidal properties. They have been used fairly widely with satisfactory results reported, but no statistical studies are available. These dyes are fairly satisfactory coagulants, but are slower acting than tannic acid and silver nitrate.

OTHER METHODS OF TREATMENT

Cod liver oil has been advocated as a primary burn treatment.³³ Its chief virtues are apparently pain relief and a theoretical value as a stimulant to epidermal growth. There is no evidence to show that it has any value in minimizing the constitutional effects of a severe burn and it is unpleasant to handle.¹⁵ Periodically a new burn ointment will be concocted and advocated in the literature on the basis of a brief trial on a few animals and "brilliant" results in a handful of patients. We know of no such preparations at the present time that possess any particular virtue. Warm continuous baths are advocated from time to time but we know of no statistical studies on burns so treated.²⁷

In this connection a word about tannic acid jelly might be in order. In 1927, we began using a 5 per cent tannic acid jelly in tragacanth base with enough boric acid to keep it from decomposing. The idea was soon taken up by the pharmaceutical houses and there are now a number of such preparations on the market each containing its own proprietary antiseptic and bearing a trade name. These preparations are useful for ambulatory burns and those about the

face where the spray is impractical. To the best of our knowledge and experience the proprietary antiseptics add nothing to the effectiveness of the preparations.

DÉBRIDEMENT

In some hospitals it is customary to do an elaborate débridement of the burn before spraying with tannic acid and silver nitrate, sometimes anesthetizing the patient and using a scrubbing brush. This is unwarranted and may produce enough shock to leave the patient unable to cope with the damaging effect of the burn. Only gentle cleansing and removal of grease which can be done without shock and with a minimum of pain should be practiced, while opening blebs and peeling off damaged epidermis. Even gross particles of carbon are not worth removing if to do so will traumatize and shock. These particles are all incorporated with the coagulum and come away with it. We have seen no instance of infection that could reasonably be attributed to such a source.

CHEMOTHERAPY

Sulfapyridine has been used with benefit by Penberthy and Weller.¹⁴ It has not been used in our series.

SENSITIVITY TO TANNIC ACID

In our experience with the hospital series recorded in this communication and a much larger number of ambulatory burns, we have encountered eight instances of acquired sensitivity to tannic acid. These patients developed a dermatitis upon application of tannic acid jelly, in one instance with severe constitutional symptoms. In all instances patch tests were positive. Each of these patients had been treated several years previously with tannic acid. Fortunately, these were trivial burns, and we have not thus far encountered an instance of sensitivity in a severely burned patient. These occurrences, though rare, point the way to the advisability of obtaining a history of treatment of previous burns with tannic acid and patch testing in doubtful cases.

STATUS OF TRANSFUSIONS

In the St. Luke's Hospital series very few transfusions were used. It has seemed hazardous to add whole blood to a vascular system already suffering from cellular concentration. The chief

benefit to be obtained from whole blood would seem to be the addition of needed plasma proteins and oxygen carrying cells to an individual who is anoxic from the cellular concentration. Plasma transfusions seem more logical.

HORMONE OF THE SUPRARENAL CORTEX

Experimental and clinical evidence of hemorrhage or cellular infiltration into the suprarenal cortex has been frequent following severe burns, but not by any means constant. Wilson²⁴ and Einhauser³⁴ have reported experiences with the use of desoxycortico-sterone acetate (synthetic preparation of the hormone of the suprarenal cortex) in severe burns. We have used it in too few instances to be significant. From experimental data which implicate the suprarenal cortex in the damaging effect of burns with apparent loss of sodium ions into the burn site, and accompanying rise in K-ions, it seems likely that this effect is only one link in the chain of burn effects and not the causative factor. This angle of the problem merits further investigation.

SUMMARY AND CONCLUSIONS

1. Data are presented from the authors' series of 809 hospitalized burns and the observations of others which tend to confirm the value of the coagulation regime as a valuable method in burn treatment.
2. The theories of causation have been briefly reviewed.
3. Some of the important factors in treatment have been emphasized.

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DISCUSSION

FENWICK BEEKMAN (New York City): This paper of Dr. Glover is very timely because he has reviewed most carefully a large series of cases treated by the tannic acid treatment. From time to time we hear people introducing new methods of treatment for burns, but in my hands I have found that the tannic acid still holds first place, and I am going to show you some figures which are almost exactly the same as Dr. Glover's.

TABLE I

Dates	No. of Cases	No. of Deaths	Mortality, Per Cent
Before Tannic Acid Treatment			
June 1919-Nov. 1925	320	89	27.8
Tannic Acid Treatment			
Dec. 1925-Aug. 1928	114	17	14.9
Sept. 1928-Jan. 1, 1940	518	36	6.9
Dec. 1925-Jan. 1, 1940	632	53	8.5

This is in no way a slight of hand trick, because Dr. Glover and I, I think, have never met before, but after I was asked to review his paper, I looked up our figures for the last ten years, and you will be surprised to see how much alike they are. (Table 1.)

In this first Table I show you our records before we introduced tannic acid, with a mortality rate of 27.8 per cent. Then I show you a mortality of 14.9 per cent, in 114 patients treated up to 1928 with tannic acid; and then I show you 518 cases treated up to the present time, from 1928, with a mortality of 6.9 per cent, giving a mortality for the whole series of tannic acid cases, of 8.5 per cent. I believe Dr. Glover's was 8.6 per cent. (Table 11.)

Here we have divided our tannic acid treatment into three periods, the first period, of four years, with 14.9 per cent mortality; the second series, of five years, 7.7 per cent mortality; and the third period of five years, 4.3 per cent mortality.

Now, during this period our technic has changed slightly. In the original 117 cases we used a tannic acid solution without any further additions. We used a certain amount of fluids, intravenous fluids, but it was not until Underhill came out with his papers that we really commenced to go into

the treatment of burns in a more scientific manner as to body fluids, and I think that might show something toward the improvement that we had in this next five years. Then five years ago we started to add silver nitrate to tannic acid, to get a more rapid treatment, and we have reduced our mortality rate again down to 4.3.

I believe that these figures are not as honest, perhaps, as they might be, for I have also believed that the type of burns we have been getting has not been (that is, all of them) as severe as those we formerly had.

Now, as to the removal of the eschar, this is a point on which I am afraid I shall have to differ with Dr. Glover. Our experience is that if the wound (burned wound) is properly cleansed before the application of tannic acid, we seldom obtain infection under the eschar. The surest way to inoculate your wound with infection is to make a hole through that eschar to inquire as to whether there is infection under it.

TABLE II
CASES TREATED WITH TANNIC ACID

	No. of Cases	No. of Deaths	Mortality, Per Cent
4 yrs. { 1926 { 1929	177	25	14 9
5 yrs. { 1930 { 1934	249	19	7 7
5 yrs. { 1935 { 1939	206	9	4 3
Totals.	632	53	8 5

In the last five or six years we have been painting the edges of our eschar, that is, at the line of demarcation, with gentian violet solution in the hope that that would prevent the entrance of infection.

We have not seen much infection. Where infection is proved, we immediately remove the eschar.

Tannic acid treatment of burns has been of great advantage to the healing of the wound because, as soon as the tanned area is separated, grafting can be done without any further preparation of the granulating surface.

I want to thank Dr. Glover for showing his figures to us, for I believe that the tannic acid treatment of burns is the best treatment that has so far been introduced for that purpose.

GROVER C. PENBERTHY (Detroit, Mich.): It is a great pleasure to have this opportunity to discuss Dr. Glover's paper because of the fact that he has really epitomized the treatment of burns from the standpoint of the use of tannic acid. In his clinic he has made a very careful analysis of his

cases. His mortality figures represent a meticulous interest and work in carrying on and caring for all the details surrounding the management of a severe burn.

One cannot approach the treatment of burns such as he has described without assuming a great responsibility, not only in the prevention of early shock by the use of sedatives, but also by the careful preparation of the wound which Dr. Glover and Dr. Beekman have emphasized.

That is important. Individuals who have criticized the use of tannic acid because of the associated infection, I think, have not properly prepared their wounds, and here again I disagree with Dr. Glover, as did Dr. Beekman with regard to the early removal of the coagulum. I think Dr. Glover has misunderstood to some extent the work of the late Dr. Davidson with whom I worked prior to his death.

Doctor Davidson found in a certain number of patients who were treated with the moist dressing because of the appearance of pus, that a certain number so treated had a return of the toxic symptoms. Because of that observation we delayed removing the crust and did not apply moist dressings.

Dr. Glover did not have an opportunity to go into this complication thoroughly. He did say, however, that following the removal of the coagulum with early application of the moist dressing, there was an elevation in the temperature. That was what Doctor Davidson assumed to be a manifestation of the return of the toxemia. For that reason, we did not use moist dressings to loosen the coagulum. The coagulum should be removed, however, in the presence of pus and it may require anesthesia to remove it. The third degree wound can then be prepared for early skin grafting.

There are many factors that enter into the lowered mortality figures: One is the careful attention to the wound, which must be treated as a surgical wound; and, secondly, the interest that has been taken by clinicians treating burns in order to work out a technic which will aid in lowering the mortality.

This study that we are carrying on at Wayne University, is a little aside from the question, but, nevertheless, it enters into this problem of mortality, and I wish to report that at the present time we are making a study of the plasma protein, hematocrit, and plasma and cell potassium in severely burned patients.

The series of cases at present is small and the potassium studies have not been completed; however, some of the findings to date are worth mentioning. The most marked increase in the venous hematocrit occurs during the first six hours. During the following twelve hours there is a gradual increase and very little increase after that time.

One patient, burned over the entire body, had a hematocrit of 70 per cent at the end of the first hour, which indicates that he had lost approximately one-half of his plasma volume.

We have found that giving 5,000 to 6,000 cc. of saline intravenously per twenty-four-hour period causes a marked drop in plasma proteins, frequently to the edema level. Intravenous blood plasma decreases the hemoconcentration more effectively without causing a drop in the plasma proteins. Whole blood given with moderate amounts of saline will tend to prevent a marked drop in plasma proteins but does not bring the hematocrit down as rapidly as plasma. Burns involving a third or more of the body are now given 1,000 cc. of blood plasma and 1,000 to 2,000 cc. of glucose and saline by vein. The remainder of the patient's fluid is given by mouth.

We have also had the opportunity of making postmortem examinations on a small number of burn cases, but have found very little. Occasionally there is a mild necrosis of the liver and usually a bronchopneumonia is present, but we have found no changes in the adrenals and we have seen no thrombosis or hemorrhage in any of the organs.

In referring to infection, in a small series of cases treated at the Children's Hospital of Michigan we have used sulfapyridine with some apparent good results. Many of these patients, as reported in the postmortem findings, show evidence of a bronchopneumonia, upper respiratory infections and infections about the wound. We have treated only a small series with sulfapyridine, but we think that this form of therapy may be a factor in reducing the morbidity and mortality.

HENRY C. MARBLE (Boston, Mass.): I am like Dr. Murray, who could not get beyond the seventh inning on the subject of compound fractures, and when the seventh inning came, I had the same urge he had.

I listened to that paper before about the treatment of wounds and everyone agreed the one thing he wanted to do was to perform a decent débridement, and then there were three roads; one went the road of Bipp, one went the road of bichloride, and another the road of salt solution; in other words, they agreed on the fundamentals. I thought that was grand. And haven't we got to go into that before we have the fundamentals? The treatment of the burned patient is the treatment of the patient.

Recently some experimental work has been done on the effects of thermal trauma on dogs. A dog had been submitted to thermal trauma. One dog had been given adequate anesthesia; the other dog was given no anesthesia. The dog with adequate anesthesia lived a great deal longer than the dog with no anesthesia.

I have heard but one fleeting word about the use of morphine. The burned patient has to have adequate sedation, and the burned patient has a tremendous outflow of serum and plasma. Immediately there is hemoconcentration, the red count goes up and the next battle must be to control his hemoconcentration, give him plasma salt solution and transfusion. This must follow and go hand in hand with the sedation. That is fundamental.

The patient must be treated, must have his morphine, must have his saline, and must have transfusions of blood to take care of the concentra-

tion. Then we come to the point, after we have treated the patient and have kept him alive: We turn to the three ways of the local treatment which, though it may seem heresy, I would think would be the least important, because the patient dies of sepsis. The patient dies as a result of his burn, and whatever treatment you give does not alter that, I believe.

I am always entertained when people talk about the new treatment of burns, about tannic acid; and if you would look into the works of Confucius, you would find that he painted them with a strong solution of tea; that would cover one side of it. Then if you read the works of Hippocrates, you find that—well, Dr. Sherman would be happy when he learned that Hippocrates put beeswax and balsam on his wounds.

So this same thing as to what we are going to put on the wound, has been discussed since the turn of the century and we are still going ahead, except that now in the matter of tannic acid we have brought in the matter of infinite pains, and the improvements we see in the charts I think are the results of infinite pains in the use of that method, which is an excellent method; but we must not forget in the use of tannic acid that the fundamentals are that the patient must have good nursing care, the patient must have morphine, the patient must have sufficient fluids, and then draw a line. Those are the fundamentals. Then whatever form of treatment you are going to apply, do so with infinite pains, and I think you will get the same results.

HUBLEY R. OWEN (Philadelphia, Pa.): One question, I want to ask is whether Dr. Beekman uses silver nitrate solution with tannic acid, with incipency of treatment, or whether he does not find it too painful to use in early treatment.

DONALD M. GLOVER (closing): I appreciate very much, gentlemen, the kind of discussion that has been given. I will answer first the last question, about the use of tannic acid and silver nitrate together. If one uses a tannic acid spray for about twenty minutes, there is an immediate precipitation of protein, and a brownish-white coagulum begins to appear or form; then 10 per cent silver nitrate is almost painless and produces quick coagulum, which in about twenty minutes is pretty tight.

I am glad that some of the points have been brought out which I had to pass over to keep within the time limit but which appear in the published paper. The importance of fluid balance has been so much emphasized that a certain amount of inconsistency has developed in an attempt to overcome blood concentration with an enormous amount of fluid in the treatment of burns. As Dr. Penberthy showed a moment ago, edema is produced and there is displacement of normal plasma proteins as a result of protein loss at the site of the burn, due to increased capillarity permeability. Fluid alone is not enough and it is probable that plasma transfusions may be part of the answer. We have hesitated to use blood transfusions extensively because whole blood added to the blood already the seat of cellular concentration, would seem hazardous. Given with caution, transfusions have

been helpful, probably because they have added oxygen-carrying tissue and blood proteins badly needed as a result of their loss from the circulation.

Dr. Penberthy mentioned the work with the potassium level. The recent experimental work suggesting suprarenal damage in severe burns has been suggestive; however, I do not believe that any one believes that the suprarenal cortex is the essential factor of the damage in the burn. The use of oxycorticosterone acetate is apparently helpful during the stage of shock and perhaps later. We have used it in only a few instances, not enough to be conclusive, but I believe this angle of the problem is one that deserves further study.

I quite agree with Dr. Marble's remarks about the treatment of the patient generally, and there is no question at all in any of our minds relative to the organization of the method of treatment of the patient as a whole. The part the organization of the hospital for systematic treatment plays in the outcome may possibly be as important as the type of treatment itself. I cannot agree with Dr. Marble upon the use of morphine, however. Burns treated with tannic acid require very little morphine.

We tried to be fair in evaluating all of the items and after we were through, we were still of the opinion that the coagulation routine contributed significantly to the results.

TRACTION PARALYSIS OF THE BRACHIAL PLEXUS

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MENTION of the subject of traction paralysis of the brachial plexus immediately suggests to the audience the question of brachial birth paralysis. This association of ideas is the result of our surgical education. We have been taught to believe that the question of paralysis of the brachial plexus is one that one sees chiefly in obstetrics. The nearly total neglect in the leading literature of paralysis of the brachial plexus in the adult is seen from the appalling fact that the most popular American reference book on surgery, written by a number of teachers of various surgical specialties, gives the question of paralysis of the brachial plexus in the adult only thirty-five lines, while brachial paralysis of birth is discussed in fifty-six pages of an average of forty lines each. The only treatise that deals justly with the question of injury of the brachial plexus in the adult is the one by Stevens, a practitioner of general surgery, published in Codman's monograph on the shoulder. These facts bring to mind a recent statement of Leriche: "Surgery will be engulfed in technical byzantinism on the day when it has become a mosaic of specialties." In America, this day is rapidly approaching, not without the help of the American Board of Medical Specialties.

The present discussion concerns only plexus paralysis due to traction. Paralysis due to direct injury to the plexus or due to pressure is not considered here. Traction paralysis may be caused by direct or indirect traction on the plexus, as for example, by blows that depress the shoulder, falls with the arm suspended or falls on the shoulder with the head turned to the opposite side, or by dragging one by the arm. Obviously, one cannot enumerate all the various ways of exerting traction on the brachial plexus that one is apt to see in industrial or traffic mishaps.

The time honored classification of paralysis of the brachial plexus according to the involved roots distinguishes the Erb-Duchene paralysis, with involvement of C₅ and C₆, the Dejerine-Klumpke paralysis, when C₈ and D₁ are affected and the complex type. This

classification is of little practical interest. It is a legacy of investigators who limited their studies to birth injuries of the plexus. While in birth injury the paralysis is frequently radicular in distribu-



FIG. 1. Radiogram of cervical spine of the adult and of the newborn. Showing the difference in the direction of the transverse processes. In the adult the angle (A) is only one-half of the angle (a) in the newborn.

tion, traction paralysis in the adult is of a truncular distribution with sensory disturbances in the foreground.

The pathologic anatomy and the clinical picture of traction paralysis of the brachial plexus are better understood when one considers the three main anatomical sites where, theoretically, the elements of the plexus may become injured as a result of traction: (1) The spinal canal; (2) the bony gutters formed by the transverse processes, and (3) the region between the exit of the roots from the bony gutter and the exit of the neurovascular cord from the axilla.

Theoretically, traction on the roots within the spinal canal may cause an avulsion. While avulsion has been demonstrated in the newborn, the literature contains no authentic case of avulsion following traction in the adult. The widely accepted opinion of the frequency of avulsion in the newborn is deeply rooted, notwithstanding the frequent clinical observations of a return of motor function following the diagnosis of "avulsion." My suspicion of this claimed frequency of avulsion was first aroused by the fact that the same well known photograph of an infant with an avulsion of several cervical roots, shown first by Taylor some twenty years ago appears in late major treatises on the subject by other authors. This is an example of stereotyped information taken for granted by subsequent writers without due criticism.

Why does traction on the brachial plexus occasionally cause avulsion in the newborn and not in the adult? The answer to this question is twofold: First, the traction on the plexus at birth is different from that in industrial and traffic accidents. In a difficult delivery the obstetrician is apt to be overwhelmed by one idea, and

that is to see the infant outside of the birth canal. The pressure exerted on the infant's shoulder and the plexus is firm, direct and prolonged in distinction to the indirect and brief traction in accident.

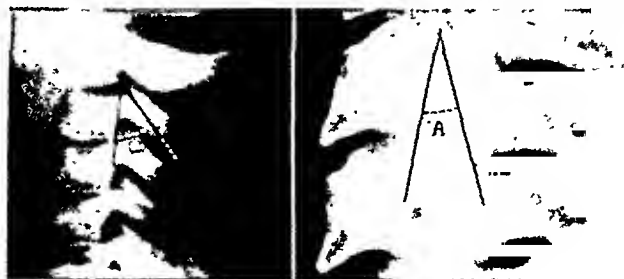


FIG. 2. Showing in a lateral view the difference in the direction of the transverse processes taking place with age. In the adult the angle formed by the longitudinal axis of the transverse process with the axis of the vertebral body (A) is only about one half of that in the five year old child (a).

Second, the course of the bony gutter and of the root in the newborn differs radically from that in the adult. I have learned this fact from anatomical dissections. Since I failed to find mention of it in texts on anatomy I have prepared photographs demonstrating these points. (Figs. 1, 2 and 3.)

In the cervical spine, beginning with C3 the upper aspect of the transverse process carries the deep sulcus nervi spinalis. This sulcus follows the axis of the process. In the newborn the transverse process is directed upward. The scaleni muscles, which take their origin from the transverse processes of C3 down, gradually, with age, pull the transverse processes downward and thus change their angle with the spinal axis. A number of other long muscles taking their origin on the transverse processes contribute to this gradual change in the direction of the processes. Obviously, the spinal root running within the sulcus nervi spinalis also changes its course. Thus, in the newborn the cervical root is under a higher tension normally, since it must "circumnavigate," so to say, the tip of the transverse process before turning downward in the neck to the point of joining the plexus. Additional pull on these roots at delivery may suffice to cause an avulsion. Besides, the root is not as strongly snubbed at the transverse process in the infant because of a poor development of the fascial tissues. This brings us to the second site of possible injury to the roots as a result of traction, the bony gutters.

On its way through the bony gutter the root is sheathed by the dural sleeve which protects it there from extrinsic pressure by hemorrhage. Theoretically, therefore, the only traction injury of the roots

within the bony gutter is a rupture of the root. Such a rupture is extremely rare; it has been mentioned, although not definitely proven, in cases where the impact on the shoulder was enormous and

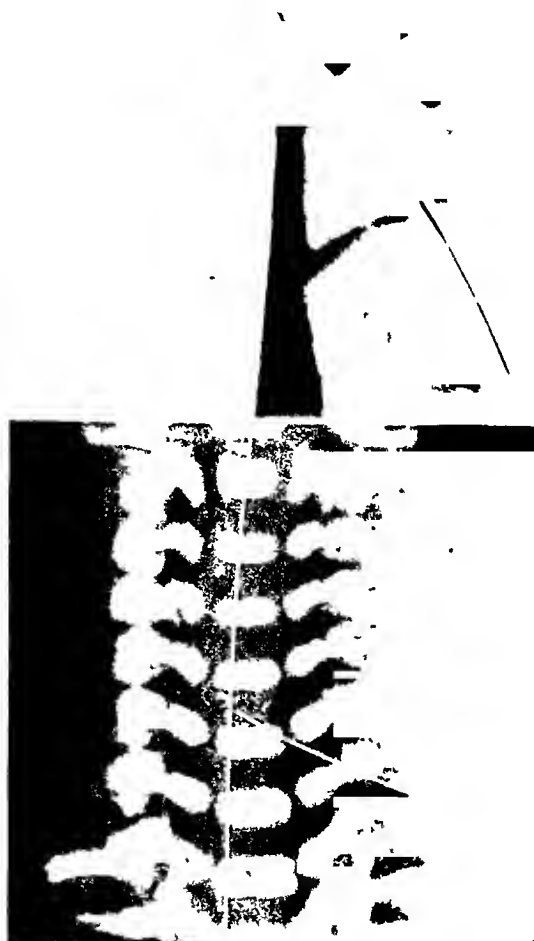


FIG. 3. Showing the change in the incline of the sulcus nervi spinalis taking place with age. A fine steel wire was passed through the sixth cervical root in the adult and in the newborn.

sudden, with the shoulder carried by an immense force down and back. The anatomical reasons for the rarity of rupture of the roots within the bony gutter are pointed out by Stevens. The roots of the brachial plexus are held firmly at the transverse processes and in the sulci by invagination of the prevertebral fascia which snubs the root at the process. This snubbing takes the strain away from the roots during traction on the plexus. (Fig. 4.)

Because of the reasons pointed out above traction injury to the plexus in the adult is usually limited to the part located distally

to the bony gutter. True rupture of the plexus is extremely rare. One finds in the literature a score of reports of rupture of one or more roots of the plexus. However, scrutiny of these reports shows



FIG. 4. Photograph of the left half of a portion of the cervical spinal cord (B). Showing the snubbing of the sixth cervical root (A-A) at the transverse process (C). (D) is the dentate ligament between C6 and C7.

that the majority of them are based on "hear-say." The reasons for this infrequency of rupture are mechanical. The force causing traction will first be broken by the skin, the muscles, the tendons and the ligaments; then, it is distributed to all fascial investments of the neck and axilla. Thus disseminated the force is reduced considerably and by the time it is transmitted to the underlying plexus it has lost most of its punch. But, while the continuity of the plexus remains intact, the investing fascial structures together with the numerous blood vessels about the plexus are traumatized severely in breaking this blow and a hemorrhagic infiltration of the surrounding tissues follows.

The brachial plexus is situated in an inverted pyramid the base of which rests on the cervical spine and the apex, at the point where the neurovascular cord enters the axilla. This pyramid is bordered by the clavopectoral fascia, the prevertebral and the deep cervical fasciae. The hemorrhagic effusion about the plexus spreads through the pyramid as in a funnel; it gravitates toward the armpit and accumulates within the fascia surrounding the plexiform part of the neurovascular cord. Numerous ecchymoses are seen also throughout all the fascial investing sheaths of the individual nerve fasciculi. If not removed, the exudate remains there until absorbed, causing numerous adhesions about the nerve bundles. Thus, while the neurovascular cord is usually more severely scarred than the individual roots, the lesions are never strictly limited; the infiltration of blood is wide and the resulting pathology diffuse so that there is no practical reason for a distinction between lesions of the roots and lesions of the plexiform portion. These findings explain why traction paralysis of the brachial plexus is nearly always of the complex type rather than the individual Erb-Duchene or the Dejerine-Klumpke types, and why the paralysis is one of a truncular rather than radicular distribution. Since the lesion is one of constriction rather than interruption in continuity, sensory disturbances are in the foreground.

Because traction injuries of the brachial plexus are occasionally accompanied by injuries of the skeleton the physician, particularly if he is a narrow groove specialist, will usually overlook the plexus injury or at best will treat it as a stepchild, paying most attention to the fracture, the dislocation or the "torn ligaments." The injuries to the plexus gradually progress so that the pains which accompany the causalgia of the plexus become especially severe months after the accident. As the adhesions increase their strangulation of the nerve bundles the motor paralysis becomes more marked. Later, the pain may decrease in intensity but the paralysis will not diminish. The erroneous opinion that the paralysis clears up spontaneously is drawn from cases of paralysis caused by pressure upon the plexus and not by traction. If pressure is not prolonged to the point of causing ischemia of the nerves, the paralysis will clear up.

The pathologic anatomy of traction paralysis as outlined above dictates the proper management of these patients. In the early cases, treatment should aim at a speedy relief of pressure upon the plexus by the hemorrhagic exudate, so as to prevent adhesions and strangulation of the nerve bundles. In the late cases radical dissection of

the scarred plexus and liberation of the strangulated nerve bundles is called for. It is obvious that delay of surgical treatment in these cases is prejudicious to the patient's interest. In trained hands an exploration of the brachial plexus above and below the clavicle is fully safe and justifiable.

In a widely known reference book on "Traumatic Surgery" the author advises to wait "four months to two years" before operating upon these patients. This advice is the result of a lack of distinction by the author between paralysis of the brachial plexus following pressure and that due to traction. Paralysis resulting from pressure will promptly clear up if the pressure did not cause ischemic degeneration of the nerve fibers. To operate in cases of pressure is, therefore, either needless surgery in cases of moderate pressure, or useless surgery in cases of prolonged pressure. There will be an occasional instance when rupture of a nerve root is diagnosed beyond any doubt. These rare cases are best left alone, since suture of a nerve root seems to be a forlorn hope.

ILLUSTRATIVE CASES

CASE I. B. K., a man, 28 years old, was loading furniture when a heavy table fell on his right shoulder depressing it and forcing his head to the left. Because of a fracture of the acromion, the shoulder was immobilized for several weeks. Persistent complaints of "pins and needles" in the arm and hand went unheeded until atrophy of the small muscles of the hand led to the correct diagnosis eight months later when the brachial plexus was explored.

CASE II. G. N., a man, 30 years old, found himself in a capsizing boat at the dock. He grasped an overhanging log with his left hand while the right hand was caught in an oar nook of the boat. He remained in his position for fifteen minutes. With a diagnosis of "torn ligaments" the left shoulder was immobilized, notwithstanding the fact that the man's main complaint was a tingling and burning pain in the ulnar three fingers and in the palm of the hand. Only six months after the injury was a correct diagnosis made and an exploration of the brachial plexus followed.

CASE III. K. R., a 50 year old truck driver, fell off a high loaded truck to the pavement. He landed on the right shoulder while the head was forced to the left side. Because he was dazed for a moment he was treated for weeks for a concussion of the brain. Persistent complaints of pain in the right hand led to the diagnosis of a traction injury of the brachial plexus two months after the accident.

CASE IV. F. S., was a 62 year old laborer. A wooden case weighing about one hundred pounds fell against his right hand pinning it down to the platform of a truck. He was forced to remain in this position for some time

with the arm in abduction and external rotation. He suffered a great deal of pain in the hand and wrist, but this was attributed to "torn ligaments." The pain in the hand and later in the shoulder persisted and finally atrophy of the small hand muscles was noticed and the brachial plexus explored nine months later.

Common to all these cases were the increasing paresthesiae throughout the involved upper extremity. A picture of a causalgia of the brachial plexus was later superseded by motor weakness. In all cases suspected skeletal injuries monopolized the attention of the attending specialist until persistent complaints of pain, occasionally accompanied by atrophy of the small muscles of the hand, led to further consultations and to an exploration of the brachial plexus. By that time they all complained of intense burning and of a boring pain in the palm of the hand and the pulp of the fingertips. Then neurologic topography ceases to be accurate so that the physician, failing to reflect on the underlying pathologic physiology, regards these complaints as malingering and exaggeration.

Common to all cases were also the operative findings. The plexus was a mass of scar tissue. The individual cords were welded together in an irregularly shaped grey tough mass. They required free and tedious sharp dissection of the cords. The smaller nerve trunks were then isolated by means of infiltration with saline. Stubborn oozing of venous and arterial blood from the resected scar tissue made the operation still more difficult.

The operative results in all cases of traction paralysis were in inverse ratio to the length of time that elapsed from the accident to the time of operation. However, even in the greatly neglected cases the pain and paresthesiae were greatly ameliorated.

DISCUSSION

GURTH PRETTY (Montreal, Canada): I believe that a discussion of this adequate paper of Dr. Kolodny requires a great deal of thought. I realized that, and also felt that I was being given this for being somewhat of a bad boy, not attending the meeting at Hot Springs last year.

True, as Dr. Kolodny has said, the literature is virtually filled with birth paralysis and birth trauma, but when it comes to the paralysis associated with accident surgery, there is very little written. Probably it may, as time goes on, get into the hands of the neurosurgeons who are rapidly encroaching on various branches of neurosurgery. Dr. Kolodny has brought forward several important and interesting facts regarding the anatomy of the bony structures associated with the brachial plexus. The spinal canal, the bony gutters for exit of spinal nerves with increased angulation as

compared to the infant, explain why we have so few cases of traction paralysis. Additional root damage is apparently prevented by snubbing of the roots by surrounding tissues and structures.

In Erb's paralysis root damage exists, while in our own experience among adults we have very few or comparatively few injuries of the traction type to the brachial plexus.

Is it possible that we miss them? No. Prior to ordering any medication or sedation, a careful examination of the extremity is made.

In fractures of the surgical and anatomical neck, there is a good deal of controversy about the treatment. Some will advise you to treat them with the arm alongside the body. Boëhler, on the other hand, puts them in complete abduction, extended and rotated. I agree with Boëhler as far as reduction of the fracture is concerned, but have experienced a good deal of trouble in mobilization of the shoulder. We have run into a certain number of wristdrop cases, although the wrist has been supported. I believe some of the bony spicules irritate the branches of the plexus, which has probably been partly influenced by hemorrhage into this inverse triangle which Dr. Kolodny describes.

The question is, whether or not some of those cases would not have shown signs of plexus traction in later stages, had we treated them by other methods.

It is true that when considering these plexus injuries, we have to study them from the point of view of injury to the roots, to the trunks, to the cords and the peripheral vessels. The reason we know so little about traction paralysis is that we have not, probably, taken the trouble or the interest to look into these cases, just the same as Codman, for instance, with his supraspinatus bursa.

Dr. Kolodny is to be congratulated upon such a scientific discussion of traction paralysis of the brachial plexus.

CLAY RAY MURRAY (New York City): I want to compliment Dr. Kolodny on the very scholarly paper which he has presented. I think there is very frequent application of some of the points he brought out in the treatment of lesions far removed from the shoulder joint. I have noted on our own service, and have had similar information from other services, that in the application of body spicas for hip and spine cases, the arms are very commonly, with the patient under anesthesia, put above the patient's head.

We have had in the last twelve years five instances of partial paralysis of the biceps with cutaneous hypaesthesia following the distribution of the musculocutaneous nerve. This was bilateral in two instances. In these cases there was no lesion of the upper extremity at all, the patient having fractured the hip. The paralysis followed application of the body spica, and the only possible mechanism was raising the hands over the head and holding them there for quite some time. It is a common practice, and care

should be taken not to get the arms too high or hold them there for a long period of time in the application of body spica.

KELLOGG SPEED (Chicago, Ill.): This is a very important paper and not to be passed over too lightly. I think it has a practical bearing in the care of peripheral nerve injuries, and especially those resulting from trauma or gunshot, and the anatomical reasons given and exposed here explain some of the differences between the injuries of the nerve further peripherally from the spine than those high up in the brachial plexus. This funicular-like arrangement of the fascial covering in the cervical spaces, which encloses the cords of the plexus, may permit compression by bloody effusion, thus indicating the necessity for early release of pressure by operative procedure.

I have seen recently three injuries, fractures of the shoulder region, treated by the hanging arm cast, in which there has been some doubt in my mind whether the pull, weight and dragging of the cast did not have much to do with the paralysis which developed. The pull on muscles by traction is also a factor of practical importance.

ANATOLE KOLODNY (closing): I thank you very much, gentlemen. There is very little I can add.

DIAGNOSIS AND TREATMENT OF POST-TRAUMATIC OSTEOPOROSIS*

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THE importance of post-traumatic osteoporosis as a major cause for the prolonged loss of function or severe aching pain, in or about multiarticular joints, which frequently follows in the wake of trivial as well as serious injury to an extremity, is not generally recognized. As a result, many innocent persons are unjustly accused of malingering or of being grossly unco-operative simply because their disability continues long after the effects of the original trauma have subsided, or after the fractured bones have had a chance to become firmly united in good position.

Post-traumatic osteoporosis is rare after trauma to the diaphysis of bones yet it is relatively common after injury, either with or without osseous fractures, to the periarticular or juxta-articular tissues. As early as 1901 both Sudeck¹ and Kienböck² studied this disease entity and showed that *inactivity* alone could not account for such a severe degree of trophic changes in bones; that these trophic changes came on much earlier than the changes which result from simple disuse; and that the reflex or trophic changes characteristic of post-traumatic osteoporosis usually came on while the extremity was still in active use. In 1926, Nobel and Hauser³ reviewed the various theories about the causation and came to the conclusion that the only theory which could satisfactorily explain all of the pathologic physiology of bone in true osteoporosis was that the disturbance was a manifestation of a trophoneurosis as was originally suggested by Kienböck² in 1901.

CLINICAL FORMS

In order to avoid all confusion with the atrophy of inactivity or disuse we shall only refer to the trophic changes in bone which follow trauma and which are associated with other vasomotor and trophic changes in the extremity, as the true post-traumatic osteoporosis. This disease entity is, therefore, characterized clinically by (a)

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partial loss of motor function of the extremity; (b) characteristic changes in the roentgenograms; (c) the constant co-existence of vasomotor and other trophic manifestations; and (d) the usual association with severe aching pain. The disturbances of the function are always more extensive than could be explained on the basis of the trauma alone, and the aching or visceral pain, when present, is greatly out of proportion with the local signs of injury to the tissues.

If we disregard the local effect of the trauma in these patients, we must still be impressed by the extensive loss of motor function and the obvious vasomotor manifestations which are present in such extremities. When the pain forms a characteristic part of the clinical picture, it has been our experience that such pain cannot be relieved by immobilization of the part; while the pain associated with simple trauma, fracture of one or more of the bones, or even tuberculous or pyogenic osteoarthritis, is definitely relieved by immobilization of the affected extremity.

Recently John Caldwell discovered four patients in his fracture clinic in whom all of the classical signs and the disability of true post-traumatic osteoporosis came on several weeks after injury to an extremity but without the aching pain. These patients will be the subject of a thorough study and report at a later date.

A common clinical form of acute osteoporosis is frequently seen after fractures of the bones of the wrist or ankle which have been properly reduced. After the removal of the bandage or cast at the end of two or three weeks, the extremity is found to be swollen and sometimes the skin is reddened. (Fig. 1.) Slight active or passive motion of the joint causes the patient great pain. Mechanotherapy, baking and massage usually make the pain more severe and the loss of function of the extremity continues to become worse. Diathermy gives only slight relief from pain and in our experience even intensive diathermy does not alter the course of the disturbance.

From the clinical point of view, the extension of the functional disturbance beyond the area of traumatization and accompanied by constant aching pain which is usually made worse by immobilization or proper physiotherapy, is pathognomonic of true post-traumatic osteoporosis. When acute osteoporosis was limited to the bones of the hands or feet, most of our patients have shown a hyperthermia of the skin over the affected parts.

The association of the subacute varieties of post-traumatic osteoporosis with cyanosis, subjective and objective sensations of coldness of the skin of the affected extremity, local edema and trophic disturb-

ances such as ulcerations, hyperkeratosis, atrophy of the skin and hypertrichosis and constant aching pain in the entire extremity, have been repeatedly pointed out by other observers. Congestion of the



FIG. 1. Characteristic gross changes in the soft tissues of the hand in post-traumatic osteoporosis during the acute or active phase of the disease process.

skin of the foot which is accentuated when the limb is placed in the pendant position, marked edema and a thinning of the skin with a disappearance of all of the surface markings giving it a "glossy" appearance is characteristic of the chronic phase of osteoporosis.

ROENTGENOLOGIC ASPECTS

Two main forms of post-traumatic osteoporosis have been described as showing constant and characteristic changes in the roentgenograms. Sudeck¹ named these apparently distinct stages in the evolution of the disease the (a) acute form and (b) the chronic form.

The so-called *acute form* is characterized by a mottled appearance of the bones due to the irregular rarefied areas in the spongiosa of the bones. This mottling is usually most marked in the carpal and tarsal bones and in the heads of the metacarpal and metatarsal bones. In advanced cases the cortex of the small bones becomes very thin and the outline of the individual bones is frequently lost. The lamellae fade into one another and produce an ill-defined or homogeneous shadow in the roentgenogram.

In the so-called *chronic form* the trabeculae of the bones are very fine and sometimes difficult to recognize. The limits of the individual bones again become demonstrable, but there still remains a general



FIG. 2. The characteristic mottling of the bones of the left hand as shown in the roentgenogram during the acute or active phase of post-traumatic osteoporosis.

loss of mineral salts. The patchy areas of rarefaction have largely disappeared. The increased strength of the bone is due to a thickening of the longitudinal lamellae since the horizontal lamellae remain very thin.

In cases of post-traumatic osteoporosis of the short bones, especially the carpal and the tarsal bones, we recognize three stages in the evolution of the disease. These three stages are: (a) *the onset*, (b) *the height of the disease*, and (c) *the reorganization*.

We believe that each of these three stages presents characteristic roentgenologic changes. This evolution of the disease from the standpoint of the roentgenologic changes can best be portrayed as follows: In the period of onset there is a general mottled appearance of the

bones in the roentgenogram. (Fig. 2.) The outlines of the bones are still easily discernible. The rarefaction continues to become more marked and more extensive. The irregular areas of rarefaction soon



FIG. 3. Roentgenogram showing the characteristic changes in the structure of the small bones of the foot during the late or chronic phase of post-traumatic osteoporosis.

disappear and the bones become uniformly permeable to the roentgen rays. This stage of diffuse and marked decalcification marks the height of the disease.

The absorption of the bone seems to spread to the neighboring bones and thus involves the heads of the metacarpals or metatarsals, then the phalanges and finally the adjoining ends of the radius and ulna or the tibia and fibula, as the case may be. Marked thinning of the cortex of the bones takes place and longitudinal streaks appear in the thinned cortex. In the region of the carpal and tarsal bones this thinning of the cortex of the bones results in the disappearance of the limits of the bones and thus transforms the entire area into a homogeneous mass which is very permeable to roentgen rays. It is at this stage that a diagnosis of tuberculous osteoarthritis is frequently made.

During the period of reconstruction there is a slow reappearance of the calcium in the bones. In most cases complete recalcification never takes place. Roentgenograms taken during this stage show that the limits of the small bones have again become visible and the longitudinal lamellae have become thickened. (Fig. 3.)

The duration of each of these stages is very variable. The factor of time seems to be of little importance. In general, however, the

first two stages are relatively rapid in their evolution, while the third or reconstructive stage is usually extremely slow. Complete anatomical restoration of the density of the bone, however, is not necessary for complete symptomatic relief or the return of normal function.

CLINICAL EVOLUTION

It is commonly believed that post-traumatic osteoporosis is a selflimited disease and that after a few weeks or months, recalcification takes place without leaving any serious deformities. Sudeck¹ stated that favorable evolution is only occasionally seen, and it is *not* the usual end result of the disease entity. It has been our experience that after the disease has reached the climax or stage of almost completed decalcification, the process of recalcification may begin spontaneously, but years later, the roentgenograms may still show thinning of the cortex of the bones and thin lamellae containing irregular areas of recalcification. From these facts one might get the impression that the disease heals spontaneously since it is also well known that the vasomotor manifestations and pain may disappear without adequate treatment. In such cases, however, the *recovery of function of the extremity* requires many months and frequently during the stage of recalcification extensive fusion of the carpal or tarsal bones takes place. This ankylosis usually causes great economic loss to the patient. Undoubtedly many of the mild forms of post-traumatic osteoporosis do heal spontaneously and give no permanent disturbance of function; therefore, one must be careful not to assume that some particular form of therapy used in any one patient is a true remedy for the disease entity under all circumstances.

TREATMENT

The treatment of post-traumatic osteoporosis has, until recently, been symptomatic and preventative rather than curative in nature. Sudeck¹ recommended minimum immobilization and then active movement in most of his cases. In 1926, Nobel and Hauser³ recommended heat to the point of tolerance either in the form of radiant heat or paraffin baths. They also advised massage and voluntary motion of the joints in spite of a little pain, *but they emphasized that forceful manipulation under anesthesia was definitely contraindicated*. Any form of fixation with plaster-of-Paris casts or orthopedic apparatus causes increased pain to the patient. Delorme⁴ recommended treatment by thyroid and parathyroid extracts and Pech⁵ advised heliotherapy.

In 1924, Clarence Heyman⁷ suggested periarterial sympathectomy for the treatment of painful osteoporosis. The relief of pain and the restoration of function promptly followed this operation.

The true function of the longitudinally coursing fibers in the adventitia of large arteries has never been actually demonstrated, yet there is little doubt in the minds of students of this problem that removal of the adventitia of the main arteries of the extremity does bring about definite changes in the nutrition in the periphery of that limb. It is our belief that these fibers in the adventitia of the arteries have a definite trophic function, and it is the interruption of abnormal trophic reflexes that course along the fibers in the adventitia that accounts for the striking beneficial results obtained after periarterial sympathectomy in patients with post-traumatic painful osteoporosis.^{8,9,10} We do not recommend periarterial sympathectomy as treatment for the true vasomotor instability of Raynaud's syndrome.

In 1934, Fraser Gurd⁶ advised the use of "walking plaster casts" and physiotherapy, and reported satisfactory clinical improvement.

The recent (1938) recommendation of roentgenotherapy for acute painful osteoporosis by Mumford,¹¹ of Indianapolis, has interested us a great deal and during the past year Dr. Jack E. Singer, of the Department of Roentgenology of the Cincinnati General Hospital, has treated four patients with acute painful osteoporosis of the post-traumatic type, and John Caldwell has had under his observation two other patients who had received adequate roentgen-ray therapy for osteoporosis.

SUMMARY OF CASES

During the eight years from June, 1932, to June, 1940, we studied eighty-four patients with post-traumatic osteoporosis in the out-patient clinics of the Cincinnati General Hospital.

Thirty-four of these patients presented the signs and symptoms of the *acute painful variety* of post-traumatic osteoporosis and were treated by periarterial sympathectomy. All of these patients who were subjected to periarterial sympathectomy had relief of the severe aching pain within twenty-four hours after the operation with disappearance of the edema and functional disturbance within a few days. These patients were able to resume their work within an average time of approximately three months. Complete return of function in the control group treated by means of physical therapy together with other conservative measures took more than nine months.

We have found that operations upon the autonomic nervous system offer a rational and effective surgical treatment for this disease entity *if the operation can be performed during the acute phases of the disease process*. The relief of pain and the sudden disappearance of the functional impairment has frequently been almost immediate and the undesirable sequellae of this disease have been prevented in the patients with acute osteoporosis whom we have studied. In previously reported studies⁸ we found that the *patients in whom the symptoms were present for more than nine months received relatively little benefit from periarterial sympathectomy*.

Four of the patients of this series were treated by roentgenotherapy according to the method of Mumford. In all cases there was relief of pain within one week after the radiation therapy was started. Subsequent follow up studies upon these patients, however, reveal that the functional disturbance does not show corresponding improvement. From our own studies of this small group of patients we get the impression that the period of disability is not greatly shortened by the roentgenotherapy but the prompt relief of pain is a great comfort to the patient, and it does permit the partial use of the extremity earlier in the convalescent period even though the degree of disability remains high.

The remaining forty-six patients came under our observation during the *subacute or chronic phases* of the evolution of the disease and were, therefore, given only intensive physiotherapy consisting of massage, functional stimulation, infra-red and ultra-violet radiation and hydrotherapy. Analysis of these patients showed that the course of the disease was only slightly shortened and the unfavorable sequellae were about as frequent as when the process was left untreated.

CONCLUSIONS

1. Post-traumatic osteoporosis is a disease entity with characteristic roentgenological changes in the three main stages in the evolution of the disease.
2. Post-traumatic osteoporosis which is left untreated may result in ankylosis of one or more of the joints in the region of the trophic disturbance in the short bones.
3. Operations upon the sympathetic nervous system offer a rational and effective surgical treatment for this disease entity.
4. Cases of post-traumatic osteoporosis treated by sympathectomy during the *active phases* of the disease respond quickly and the undesirable sequelae of the disease are prevented.

5. Periarterial sympathectomy is usually sufficient for cases of post-traumatic osteoporosis which is limited to the distal part of the extremities.

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DISCUSSION

JOHN A. CALDWELL (Cincinnati, Ohio): It has been my privilege to be associated with Dr. Herrmann in this work principally as a supplier of material. I was infected with his enthusiasm from the first and since then we have gone along together.

It is not possible, even if it were necessary, to add anything more to what he has said, but probably to emphasize a little bit some of the outstanding features which make it important to persons who are dealing with the surgery of trauma.

First, I should like to call attention to the fact that he has mentioned that it is very frequently associated with trivial injuries. Quite a number were not associated with any fracture at all, and one of the things that we have begun to regard as almost symptomatic of the condition is that it is very likely to develop in fractures that have been well reduced.

The Colles' fracture, impacted in such good position that the parts require little manipulation, is quite prone to be followed by osteoporosis; while the badly comminuted and smashed os calcis in severe injuries of the foot is frequently found exempt from this condition.

Great injustice is done these patients by lack of recognition of this condition. I can best show that by reciting a recent case of a young man who fell down an elevator shaft and sustained a Pott's fracture which was easily and

well reduced under local anesthesia. He had excruciating pain all night to such an extent that he required anodynes. That continued for several days, so that I felt it was necessary to inspect, and on taking off the cast, found it was perfect. There was no pressure sore, nothing at all to account for this condition, and a second cast was applied and his pain continued. His foot remained painful for the ten days he stayed in the hospital.

At that time he still said it was painful and I arrived at the almost inevitable diagnosis of a functional condition. I interviewed first his employer and he gave me a very definitely warm earful. The patient was a valuable employee and compensation was not a question. They were anxious to do everything for him.

At the end of two weeks, on removing his cast and taking contrasting plates of the two ankles, we could see what we thought was very slight change in the affected foot.

Without further detail I can say that this patient went on to a complete osteoporosis of a very aggravated degree. He would not submit to a sympathectomy. He received x-ray treatment, and it has given him definite subjective relief, but it has not been followed by corresponding improvement in the bone picture.

The principal thing in our experience, to bear in mind is that this is a real, definite, pathological thing which must not be mistaken for a neurosis. This atrophy is entirely different from the atrophy of disuse, in that it appears very much more promptly, develops more rapidly, and is not a diffuse demineralization, but the spotty, rotten wood appearance, which is quite characteristic to anyone who is familiar with it.

THOMAS PETERSON (Boston, Mass.): I should like to ask whether Dr. Herrmann believes the use of novocain has anything to do with the production of osteoporosis, and also I should like to know whether he believes age has anything to do with its production.

JOHN A. CALDWELL (Cincinnati, Ohio): May I have a minute to speak about novocain? I can answer very definitely that novocain has nothing to do with osteoporosis, because a great many of these patients have not had fractures at all, so that they have had no treatment; others have had fractures with so little displacement that they require no manipulation. We have had several cases in which the injury was at a distance from the development of the osteoporosis, for instance, a fracture of the knee joint, and the patient had an osteoporosis of the foot and ankle.

NELSON J. HOWARD (San Francisco, Calif.): I should like to ask whether the authors have had experience with the sympathetic block of the lumbar sympathetic or thoracic system, for the reason that the sympathetic is segmental, and the periarterial sympathetic, too, and I have wondered what the effects would be from the more complete block.

LOUIS G. HERRMANN (closing): I have no positive information concerning the possible rôle which local injections of novocain, in and about joints,

have upon the productions of osteoporosis. It is not uncommon to see osteoporosis follow relatively trivial injuries to the periarticular tissues, but I would be of the opinion that blocking the sensory nerve endings in and about the joints would tend to reduce the chances for the development of true osteoporosis.

Osteoporosis occurs mostly in the third, fourth and fifth decades of life and it is rarely observed in children.

Extensive structural changes in the peripheral arteries which occur in the sixth and seventh decades of life may give rise to osseous changes, visceral pain, local vascular and trophic changes and produce a syndrome which is not unlike this post-traumatic type of osteoporosis.

In regard to Dr. Howard's question, I might say that it is possible to interrupt these pathways for abnormal reflexes by blocking the regional sympathetic chains. Such a procedure, however, requires considerable special training and skill and I do not believe should be routinely done by the average general surgeon. We are convinced that periarterial sympathectomy is a simpler procedure and a more effective way of assuring a complete block of the abnormal reflexes.

Recent clinical studies have given us the information that the major pathways of these neurotrophic fibers are in the adventitia of large arteries or are at least segmentally distributed to the periarterial network from the peripheral somatic nerves. These fibers do not course through the regional sympathetic chains or ganglia and this, we believe, accounts for the failure of improvement of post-traumatic osteoporosis after the surgical removal of the regional sympathetic ganglia (sympathectomy) or the interruption of the rami to the ganglia (ramisection), while striking improvement usually follows the denudation of the major artery to the affected part. In the present state of our knowledge we do not recommend operations upon the sympathetic ganglionated cords in the management of post-traumatic osteoporosis.

It has been a real pleasure to have the opportunity of discussing this problem before you and I hope that I have emphasized the importance of this troublesome complication which follows so frequently in the wake of traumatization of an extremity.

THE POSSIBLE ETIOLOGIC RELATIONSHIP BETWEEN A SINGLE TRAUMA AND MALIGNANT TUMOR

HERBERT H. DAVIS, M.D.
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IT is generally agreed that chronic irritation or frequently repeated mild trauma may be the exciting cause of a malignant tumor in a susceptible individual. This discussion does not consider the above causes, but refers only to the question of a single trauma as a possible cause of a malignant tumor. Patients often consult their physicians following an injury with the fear that this may cause the development of cancer. The medicolegal aspect of the question arises even more frequently. In connection with the Workmen's Compensation Law, the relationship of trauma to neoplastic lesions is becoming increasingly important.

Recently I testified in such a case. The main facts were as follows:

A laborer, age 48, in the employ of the State of Nebraska, while driving a car, struck the left side of his jaw against the side of his car when it hit a bump. Three weeks later he noticed a swelling below the angle of the mandible. The tumor continued to enlarge, and a month after the injury he noticed a weakness of the muscles of the left side of his face. Soon after this pain developed in the region of the mass and extended upward behind the left ear and into the left temple.

Examination four months after the injury disclosed a large cancerous mass in the left superior deep cervical lymph nodes. Biopsy from the mass showed it to be a metastatic adenocarcinoma. The patient later consulted a so-called cancer specialist who used an arsenic paste on the neck region which caused a very extensive slough. Ten months after the accident he died of the carcinoma.

His family brought legal action against the State of Nebraska, claiming that the injury sustained while he was working for the state resulted in the carcinoma which caused his death.

The testimony was very interesting. The plaintiff's physicians testified that the injury of the deceased, which was definitely described as occurring up over the cheek and mandible rather than over the neck, was the cause of the cancer. When asked where the primary growth had occurred, they stated in the mouth, and one even stated that the carcinoma might have arisen in the bone of the mandible. The State showed that no sign of a

primary growth had appeared in the injured region; that the blow had not been in the area of the neck, where the metastatic carcinoma was; and also that the type of cancer found microscopically would not have arisen in squamous epithelium, which is the only type of epithelium in the area struck. Unfortunately, no primary growth had ever been located and no necropsy had been done. In spite of this testimony, the verdict was for the plaintiff.

It is realized that a definite scientific opinion cannot always be given regarding the relation of a single trauma to the subsequent development of cancer. Often, however, a definite opinion may be given. In the above case, for example, scientific evidence should show that no tumor arose at the site of injury, and that epithelium at the site of injury was not the type for the development of an adenocarcinoma. Therefore, the carcinoma could not be caused by the injury to the jaw, and the verdict was scientifically incorrect. A large number of such cases arise under workmen's compensation laws. Too large a number are decided incorrectly by the courts.

HISTORICAL

Askanazy¹ stated that the literature dealing with the subject was only a "collection of anecdotes," and that it contained many highly uncritical studies. Those interested in this question are referred to an excellent review of the literature by Ophuls² in 1921 and Knox³ in 1929, and the quite thorough discussion by Ewing⁴ in 1935.

The relationship of trauma to cancer was discussed by Lowenthal⁵ of Bollinger's Laboratory, at Munich, in 1895. From 800 cases in the Pathological Institute at Munich from 1870 to 1895 there was a history of acute trauma in 358. So little critical analysis was made that this article probably proved nothing. Schimmelbush⁶ felt that conclusions based upon compilations of case histories were absolutely unscientific and not of great value. He stated that scientific matters could not be based upon untrustworthy and unreliable evidence, and that on this subject all the evidence was essentially unreliable.

In 1898, Coley⁷ studied the role of injury in the development of sarcoma. In 170 cases there was a history of trauma in forty-six (27 per cent). These cases, again, were not thoroughly studied.

Owing to the growing interest in this subject, it was thoroughly discussed at the Second International Conference on Cancer at Paris in 1910. At this time Theim⁸ laid down five postulates which had to be fulfilled before trauma should be considered the cause for the subsequent development of cancer. These were as follows:

1. The occurrence of the trauma must be proved.
2. The trauma must have been severe enough to be effective.
3. The growth must appear at the place likely to have been injured by the trauma.
4. It must be reasonably certain that the traumatized part was normal before the accident.
5. The time elapsing between the trauma and the appearance of the tumor must agree with our scientific experience on the rapidity of the development of the particular kind of tumor under consideration. It must not be less than a few weeks or over two years unless there are symptoms which bridge over the intervening period.

Of these rules, No. 4, regarding the certainty that the traumatized part was normal before the accident, is the hardest to prove.

Lowenstein,⁹ in 1910, in a long monograph on the subject, analyzed from the literature 261 cases of malignant tumors—seven from Heidelberg and three from Frankfurt—according to the histories, which were considered traumatic in origin. This paper was superior to previous articles inasmuch as an attempt was made to apply critical standards to the histories, and the author appreciated the need of scientific methods in making conclusions. He presented tables giving clearly the lapse of time between the injury and the development of the tumor. He included only those in which the injury was described as being at the exact site of the subsequent tumor.

Brosch¹⁰ believed that a single trauma could not cause a tumor, but that the early productive and reparative changes observed in scars were essential forerunners of the neoplastic process. This fact accounted for the inability of experimenting pathologists to produce tumors in normal tissues. Goebel¹¹ also stated that a single injury never caused a malignant tumor, but that chronic irritation, repeated injuries and scar tissue might do so. Oberndorfer,¹² too, believed that some underlying predisposition must be present in addition to trauma.

Virchow,¹³ while admitting the fact that the influence of traumas could not be dogmatically denied, stated that there must be some as yet unknown predisposing factor in the patient, and also that the trauma must have been implanted on pathological tissues. Ribbert¹⁴ opposed the theory that a trauma could cause a tumor, but admitted that the possibility must be conceded. He had never seen a clearly demonstrated case.

Mock and Ellis¹⁵ reviewed the literature. They quoted Bloodgood¹⁶ as saying in an address before the Ninth Annual Convention

of the International Association of Industrial Accident Boards and Commissions, at Baltimore, October 11, 1922: "In my own group of now 1,000 bone tumors, of which perhaps 400 are sarcoma, I have but two cases in which directly after the injury an x-ray was taken showing a negative bone." Mock and Ellis reported nine cases which they believed fulfilled the postulates. Of these, two were metastatic tumors, one a teratoma of the testis following several injuries, and one a sarcoma of the bone in which the sarcoma was likely existing before the injury. In conclusion they said: "There is no justification for assigning trauma as the etiologic factor in any particular case, unless this can be proved with scientific accuracy. In the great majority of cases commonly reported as the result of trauma, such an etiology cannot be scientifically established."

McKendrick¹⁷ asserted that there is no authentic case quoted in medical literature in which it can be proved beyond a doubt that fracture caused sarcoma.

Only a few of the many authorities have been quoted. However, more of such reports seem unnecessary, as they are all very indefinite and not based upon scientific data.

WAR RECORDS

A group of authorities have studied records of the first World War in regard to this matter. The general impression was that no greater percentage of tumors could be observed in war veterans than in civilians. In the period since the war no increase in the incidence of tumors has been found. The age of the soldiers was the age of people ordinarily suffering from sarcoma. In studying a large number from the Western Front, Pick¹⁸ was able to find only two cases of sarcoma which he could even suspect of having arisen from war injuries. In the large number of cases studied, this would be no more than would be found in any similar age group of people.

The French Association for the Study of Cancer investigated this subject in 1918 in the light of experience obtained during the war. Some of the leading pathologists and clinicians discussed the problem and practically all, with the exception of Berard,¹⁹ thought that trauma had nothing to do with the appearance of a tumor. Berard had previously given his opinion at the Paris Conference in 1910.

Lowenstein, in his military service from 1889 to 1917, found no increase in the percentage of sarcoma. In the Prussian Army, from which he obtained his figures, he found only one case of post-traumatic tumor in 15,000 cases.

Forgue²⁰ showed that the regional distribution and age distribution in 536 cases of cancer were practically proportional to the like distribution in the male population not in the service.

Von Hansemann²¹ stated that not only was there no increase in the number of tumors following the war, but also no new types appeared.

THE ELEMENT OF CHANCE

From the records of the New York State Industrial Compensation Bureau, Lewy²² found thirty-seven cases of malignant tumors among 26,389 injured persons. In few of these cases could the traumatic origin be established as reasonable. This ratio was about 1 to 700, or approximately that of the general population at the age of fifty.

Ewing stated that French medicolegal experts reported the occurrence of as low as five or six traumatic tumors among 100,000 injuries.

Knox estimated that, as the average life of a patient with cancer had been computed to be about two years, there should be in the population as a whole some 250 persons in each 100,000 who had cancer in some stage, in addition to those who were to die within the year. In other words, besides those who died of the disease, one person in 400 of the whole population probably had cancer in some stage of development. As sarcoma formed about one-tenth of the total of malignant tumors, 1 person in 4,000 might have an unrecognized sarcoma. He stated that the possibility of a trauma calling attention to a tumor already present must be recognized in any study of the relationship between injury and the production of a sarcoma.

Williams²³ showed that men were more subject than women to trauma, especially to the more severe injuries such as fractures, sprains, and dislocations. In his material, however, men had fewer cases of cancer than women, a proportion of 1 to 1.7. In commenting on this, Knox stated that the difference in these figures was due to the frequency of cancer occurring in internal organs, which are rarely traumatized. Therefore, it is not as effective an argument as first appears.

ANIMAL EXPERIMENTS

Experimental cancer is now being produced by many agents but always under quite specific conditions not related to trauma. Knox and Ewing have both stated that attempts to produce tumor by trauma experimentally have all failed.

Most animal experiments on the subject of trauma and malignant tumors concern the effect of trauma upon an already existing malignant tumor rather than the role of trauma as cause of the tumor. In this latter type of experiment Lubarsch²⁴ concluded that trauma could be accepted as a factor in growth if (a) violence was severe, localized, and long continued at the same point at which the tumor later appeared; and (b) the histologic structure of such a tumor made it reasonable that the growth was due to injury.

In a series of 12,000 autopsies on the bodies of mice dying at all ages either from natural causes or, in a relatively small number, from accidents, Slye²⁵ found only eighty-seven mice with neoplasms meeting all the criteria of sarcoma. In at least eleven of these, sarcoma arose at the site of previous injury. She had no knowledge of how many of the other seventy-six had received injury at the point at which they subsequently developed sarcoma; although injuries to mice are numerous, especially among the males, which often receive wounds in fighting. She found that the influence of heredity in determining the development of sarcoma at the site of old wounds was especially noticeable and important in this series.

CASE HISTORIES

In the literature many cases have been reported in which a single trauma has been thought to be the cause of cancer. A large number of these reports have referred to sarcoma, especially to osteogenic sarcoma. Meyerding²⁶ at a conference at Memorial Hospital on the treatment of bone sarcoma reported 100 cases of osteogenic sarcoma. Of this group, he found a history of trauma definitely positive in forty-two cases, definitely negative in eight and not stated in fifty. In his discussion he stated, "I think it is significant that 50 per cent of these patients were in the most active period of life, eleven to thirty years of age, and that 75 per cent of the tumors developed at sites of common injury. There must exist some unknown general condition among these patients which allows cells to become malignant following trauma as an exciting cause."

In this same discussion Simmons²⁷ stated, "Osteogenic sarcoma is usually seen in a healthy individual. A history of trauma followed by the usual symptoms of pain and swelling which subside, but which are followed after a period of from four to twelve weeks by a recurrence of pain is very suggestive of a primary malignant bone tumor."

Collins²⁸ analyzed fifty-one cases of malignancy of the testis. He found about thirty-five, or 68.6 per cent, gave histories of prior

trauma. However, the casual relationship was not adequately discussed. In many of them the malignancy did not arise until years after the injury.

Leighton and Schmidtke²⁹ collected from the literature a group of cases of malignancy with trauma as a possible cause. To these they added a brief outline of case histories of seventy-four similar cases from the Barnard Free Skin and Cancer Hospital in St. Louis. A large number of their cases were cancer of the skin.

Rixford³⁰ considered trauma the cause of cancer of the breast in the following case:

A boy, age 17, while running fell on a tree stump, striking his right breast. Seven days later, because of pain, swelling and soreness, he consulted a physician, who found the breast markedly swollen, red, hard and discolored. The skin was abraded and the nipple and areola injured. His temperature was 101°F. Axillary nodes were enlarged. Within a few weeks the breast became normal, except for a small lump directly beneath the nipple. Eight weeks after the injury the swelling was increased. Five months after the accident, mastectomy was done, but no microscopic examination made. The patient died four years later with widespread lymphatic metastases.

Because of the importance of the case the records were submitted to Dr. Ewing, who reported, "There is no escaping from the conclusion that in all probability, if not a certainty, the boy presented a genuine case of traumatic mammary cancer."

On the basis of case histories alone, it is often impossible to prove either that the single trauma did or did not cause development of a malignant tumor. The possibility is quite definitely ruled out unless details of the case conform with Theim's postulates.

CONCLUSIONS

1. A single injury to previously healthy tissue has never been definitely proved to cause cancer.

2. Nobody has succeeded in experimentally producing a series of malignant tumors by trauma.

3. The element of chance would account for the incidence of trauma in a fair number of cases in which cancer developed. The general impression of those who have studied large numbers of injured people is that they show no increase of cancer over those who have not had single injuries.

4. On the other hand, in individual patients, it may not be possible to disprove absolutely the etiological relationship. Even to

consider trauma as a cause, the following postulates must be fulfilled: (1) The authenticity of the trauma; (2) the adequacy of the trauma; (3) the origin of the tumor at the location of the injury; (4) the previous integrity of the injured part; (5) a reasonable time limit between the injury and the appearance of the tumor; and (6) the positive diagnosis of the presence and nature of the tumor.

5. Trauma reveals many malignant tumors. Whether it can actually cause a malignant tumor is an unsettled point.

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DISCUSSION

ARTHUR R. METZ (Chicago, Ill.): In considering the possible etiological relationship between a single trauma and malignant tumor, we should keep in mind three generally accepted facts:

1. The cause of malignancy is unknown.
2. It has been impossible to produce experimentally malignant conditions at will.

3. We have no way of knowing when a malignant condition actually begins.

As a rule malignant tumors are not recognized until a palpable mass occurs or pain develops. Any trauma occurring to the patient during this unknown silent period may be wrongly accused as being the exciting cause.

Some recent writers on this subject, such as Reed and Emerson, Indianapolis, in 1938, made the following statement: "That cancer may result from the single trauma is emphatically denied although this has been claimed for all types of malignant tumors. We do not know the cause of cancers, hence our conviction that no malignant growth is ever the result of a single trauma, is based on indirect and unscientific evidence."

Richard J. Behan, in his book "Relation of Trauma to New Growths," in 1939, wrote as follows:

"Heredity, constitutional predisposition, and other contributory causes are generally so associated in its origin that the possibility of a single indispensable agent acting as a sole exciting cause is universally doubted."

The same author quotes Knox as follows:

"It has never been possible to produce a malignant growth experimentally in animals by a single trauma. We must be cautious of the role which trauma plays in the production of cancer, for trauma because of its dramatic appeal and easily conceivable possibilities may assume a disproportionate prominence among the many influences which are necessary in the causation of a malignant growth."

Every surgeon at time of operation cuts tissues with a scalpel and scissors, applies many hemostats to epithelium and connective tissue, clamps blood vessels and ties catgut and silk ligatures, so that in every operative wound there is a certain amount of necessary trauma. To my knowledge I have never heard any surgeon with an extensive experience admit that his operation was a cause of a carcinoma or sarcoma. I have never heard a surgeon suggesting or considering the possibility of a malignancy developing in a wound unless he was operating on a malignant condition that he knew was present at the time of operation.

In following the injury reports of a large railroad during the past twenty-five years, where the number of accidents have totaled over 175,000, there has never been, to the knowledge of the Claim or Surgical Departments a claim made for an injury producing or aggravating a malignancy. In this series of injuries, fractures were present in about 10 per cent of the cases.

In another series of injuries totaling 47,000 among employees of railroads and insurance cases, there has never been, to my knowledge, a case of malignancy developed or has there been a claim made.

In another series of 6,000 fractures during the last twenty years, which have been confirmed by x-ray and followed through to recovery, there has been no case complicated by malignancy.

It is interesting to note that some of the areas of the body that are exposed to the greatest amount of trauma, namely, the soles of the feet, the

palms of the hands and the bridge of the nose, where the weight of glasses is constantly pressing, we almost never see a malignancy develop in these areas.

It would seem logical to conclude that if a single trauma could produce a malignancy, it would become a recognized complication of operative wounds. At present, surgeons who have a vast operative experience are not reporting or considering malignancy as a complication in general surgery when the case is not primarily of a malignant character.

In the large volume of negative evidence that can be produced, it would seem conclusive that a single trauma could not produce malignancy, and that this Association could best devote its efforts to aid further in the research on malignancy and help in seeking the true cause. Until the true cause is actually found, and malignancy can be produced experimentally, we should not hesitate to admit that we do not know the cause of cancer.

JOHN R. NILSSON (Omaha, Nebr.): Before coming here, I had an opportunity to read over Dr. Davis' paper and also writings of others on the same subject, and I think Dr. Davis answered the question in his conclusions by saying that it is still a controversial question.

Many of the German and French writers still hold to the fact that trauma does cause cancer. Others are equally positive that it does not, and all those who say it does not give as their two main reasons: First, that we have thousands of cases of injury on record without a carcinoma following. Second, they refer to the work of Maude Slye with her three strains of mice, one strain in which there is no predisposition to cancer, one with predisposition to skin cancer and one with predisposition to lung cancer.

When these three strains are subjected to trauma of the skin, only those predisposed to skin cancer developed cancer, and always at the site of injury.

I am not here to tell you that trauma causes cancer, but it is a question that comes up with us, and while I cannot talk in as large figures as Dr. Metz, 200,000—I am with a different railroad (The Union Pacific), and we do not have quite as many accidents—I have had cases in which trauma has apparently resulted in new growth, and I am going to take a few minutes to review these cases:

CASE 1. H. G., age 47, was struck on the side of the leg, lower third of the femur, by the side rod of an engine. He had a bruised spot there, swelling and discoloration. He did not pay much attention to it. Three or four months later he noticed that the swelling had not disappeared. There was apparently a growth. He went along and continued his work as if it did not cause him much trouble. He went a few months longer and then consulted a doctor, and in one year's time the swelling had not disappeared.

They did a biopsy and found a fibrosarcoma. He was treated with a deep x-ray, very extensively. When I saw him three years later he had a large ulcerating area on the outer lower third of his femur, caused by x-ray. It

went from bad to worse. Finally, he was operated upon in one of the large clinics of the country. They did an amputation and following that he had metastases to the groin and the glands in his pelvis, and in less than a year from the time he was operated upon he died of earsarcoma.

CASE II. A. M., age 52, was struck in the elbow in April. The following August he had a tumor. He had a bruised spot there and when we examined it, we simply thought it was probably a blood clot, an organized blood clot. I removed it and it was in the faseia, not eonnected with the bone, and that proved to be a sarcoma. That was in August. In November, four months later, I did exaetly the same thing. He had another sareoma, a recurrence in the same plaee.

CASE III. The patient, age 66, came to us in March and said four months before, or for the past four months he had been having pain in the lower third of his right leg. This man was apparently in perfect health and he said, going into the history, that he had a habit of showing how strong he was. He would take a soft flat iron poker and strike himself aecross the leg. Whether that had anything to do with it or not, I do not know but his leg was amputated. It had an osteosarcoma and he lived less than a year after his amputation.

CASE IV. A farmhand, age 18½ years, while riding a traetor bruised the upper third of the lower right leg, the proximal end of the fibula. There was the usual swelling and discoloration. He did not pay much attention to it. When it pained him, he consulted a doetor and he was told that he had a charleyhorse. That was in June. In July the pain beecame worse so he consulted a surgeon. A biopsy was done and it was found that this was a sareoma. The leg was amputated and he died within one year from the time of operation.

The history in the eases enumerated gave us no clue as to any pre-existing, predisposition to caneer.

PHILIP H. KREUSCHER (Chicago, Ill.): I think such a fine paper as this should be reprinted and sent to the industrial commissioners all over the United States and Canada.

While I was eonnected with the Industrial Commission of the State of Illinois, several eases came under my observation:

One was a young woman about thirty years of age, who was carrying a heavy basket on her shoulder. The basket slipped and she sustained a rather severe abrasion over the spine of the scapula. Two and one-half months later a tumor developed in that area. Biopsy showed this to be a sareoma and the entire scapula was removed. In spite of this radical and rather prompt surgery the patient died of generalized sarcomatosis.

Another ease was that of a young man who was struck on the shin by the door of his automobile. In about two months a tumor developed over that area, which was about four inches below the knee joint. Biopsy showed sareoma and after several days the leg was amputated. The patient died within four months.

I think it is impossible to produce artificially a sarcoma by repeated trauma, but ever so often a tumor develops following trauma. One must be able to state his opinion in his testimony before the commissioners and the courts. It is difficult to convince a judge and jury that not all sarcomas or malignant growths are preceded by trauma. I believe that it is a step in the right direction to educate not only ourselves as surgeons but also those who rule and have the right to rule and from whose decision there is no recourse.

HERBERT H. DAVIS (closing): I wish to thank the discussers.

In regard to individual case histories, it is very easy to collect large numbers of cases that look as if a malignant tumor was caused by an injury. In taking a history of any individual, irrespective of the complaint, and asking whether he bumped himself or received any injury, almost everyone has. Therefore, considering these cases, we have to say that trauma is so frequent that the coincidence of the two coming together cannot be ruled out. On the other hand, we cannot make a definite statement that trauma cannot cause an injury. It depends upon whom the burden of proof lies. We can say definitely, however, that any case even to be considered as having been caused by trauma, must answer the postulates I gave in my conclusions.

THE PRESERVATION OF TENDON FUNCTION BY THE USE OF SKIN FLAPS

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INJURIES to the hands, which cause extensive loss of soft parts exposing the tendons, present problems whose solution will determine the amount of ultimate function. The preservation of the tendons will determine the functional result. Exposed tendons will gradually slough unless they are covered and will not function unless they are covered with fat. In cases of severe injury in which there has been a loss of overlying tissue, a flap must be used to carry the fat and keep it viable until it secures its circulation from its new site.

The following cases are reported to illustrate the various methods which can be employed in the treatment of these patients. Three of these cases were industrial accidents and the fourth was an accident which could well be industrial.

CASE REPORTS

CASE 1. A white male, age 18, was admitted to the hospital for a crushing injury to his right hand which had been caught in a press.

Three weeks after admission he was referred to us to determine whether the hand should be amputated. (Fig. 1.) The skin had sloughed from the dorsal surface of the wrist and the palm. The fingers were devoid of skin with the exception of the little finger which appeared to be normal except for a flexion deformity at the distal joint due to a fracture of the joint. The ends of the other fingers and thumb from the second joint were necrotic and separating. The dorsal surface of the hand showed exposed tendons which were sloughing. There was some skin near the base of the thumb and at the commissure between the thumb and the index finger. He could move the fingers and it was deemed worthwhile to save the hand if that amount of function could be preserved.

The patient was treated for a week with Dakin's solution to clean the infection and then an Ollier-Thiersch graft was taken from the thigh and placed on the palmar surface. A gauntlet flap was then raised on the left abdomen and the hand sutured to the flap which covered the exposed tendons on the dorsal surface. The abdominal skin beneath was approximated with silkworm gut sutures. (Fig. 2.) The necrotic ends of the thumb, index and ring fingers were removed. The end of the middle finger was not

removed because it had not demarcated sufficiently. A dressing of silver foil was placed against the graft and the hand was immobilized with adhesive straps. The healing was uneventful and three weeks later the ends of the



FIG. 1. Case 1. Degloved hand after a pressure injury. The skin is lost from the palm but the fat remains. The skin with the underlying tissue is lost from the dorsal surface exposing the tendons. The ends of the fingers with the exception of the little finger are sloughing.

flaps were severed under local anesthesia. (Figs. 3A and B.) The graft had taken satisfactorily on the palm. A few days later, after the graft had dried out, the margins of the flap were sutured in on the sides of the hand. (Figs. 3C and D.) The patient was discharged from the hospital two weeks later. He had some function but the hand was stiff. Massage was instituted and function greatly improved. A year later the scar was relaxed in the palm by splitting the scar and grafting. The patient can now use a typewriter and



FIG. 2. Case 1. The hand has been placed under a gauntlet flap covering the exposed tendons. The necrotic ends of the fingers which had demarcated have been removed. The palm of the hand has been covered with an Ollier-Thiersch graft.

use the hand freely. The only handicap is the shortness of the fingers. This will be corrected by relaxing the commissures and shifting the flap. (Fig. 4.)

Comment. The treatment should have been started sooner. The time lost in covering the tendons permitted them to become adherent so that function was more difficult to secure. The secondary grafting may have been avoided. The function this patient has well justifies preserving the hand.

CASE 11. A white male, age 19, was admitted to the hospital for treatment of a crushing injury to the hand, which had been caught in a press. The distal ends of the little and ring fingers were crushed and were ampu-

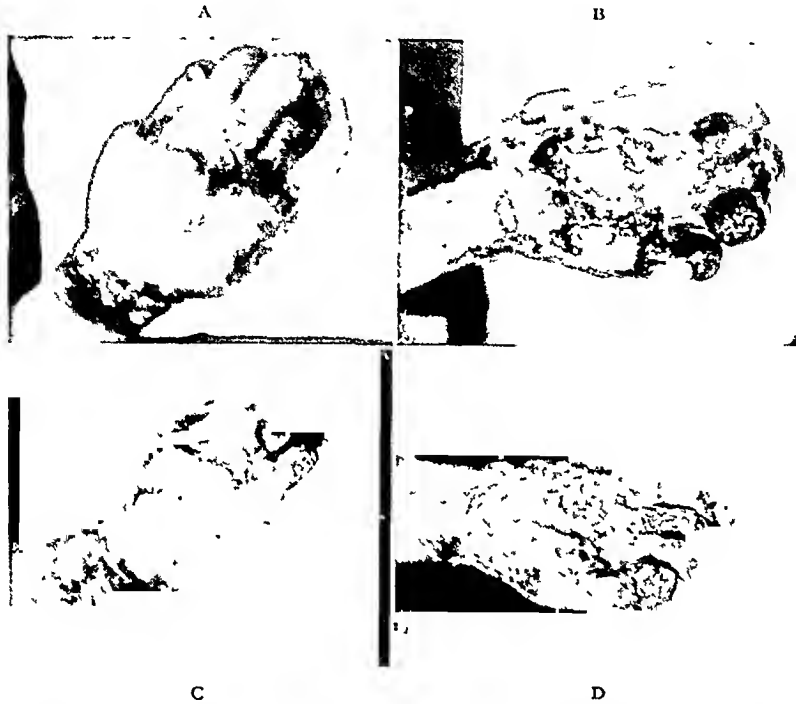


FIG. 3. Case 1. The flap had been cut from the abdomen three weeks after it had been attached. Note the margins of the flap, B. The graft had taken fairly well covering most of the palm. C, dorsal surface of the hand after the ends of the flap had been sutured into place. D, hand healed; swelling still present.

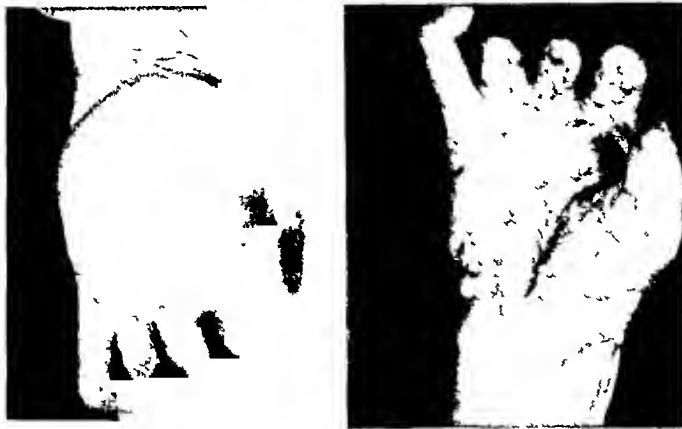


FIG. 4. Case 1. The scar which had contracted on the palm had been split and grafts taken from the thigh and sutured in. The margin of the flap had been adjusted to give more relaxation.

tated at the second joints. The skin from the outer surface of the hand behind these fingers with the underlying fat had been pinched off and was

hanging by a small pedicle near the wrist. The surgeon replaced the flap and started compressing. The flap began to slough after a few days and two weeks after the accident the patient was referred to us for treatment. (Fig.



FIG. 5. Case 11. Degloved portion of the hand with the tendons exposed on the dorsal surface. The ends of the fingers had been amputated because they had been crushed. A double pedicle flap had been raised on the abdomen and sutured back with a sheet of rubber protective tissue beneath to prevent adherence of the flap to its base.

5.) The flap was removed and the area compressed for three days. The little finger was degloved as was the ring finger. The tendons of the outer half of the hand were exposed and were beginning to slough. A double pedicle flap was raised on the right abdomen and sutured back into place with a sheet of rubber protective tissue beneath. Ten days later the distal end of the flap was cut under local anesthesia and the following day attached to the denuded area on the hand. There was some infection but the flap held and



FIG. 6. Case 11. Flap had been sutured over the exposed tendons. The stump of the little finger tended to flex. The scar was interfering with motion.

the tendons remained covered. Three weeks later the other end of the flap was cut and sutured into the hand covering the remaining raw area. The patient was discharged two weeks later. (Fig. 6.) Massage was started and function returned. However the little finger tended to stay flexed so the flap was shifted six months later with a satisfactory result. (Fig. 7.) The finger can now be used satisfactorily and he has resumed his occupation.

Comment. A pinched flap will very rarely survive and should not be sutured back if there is a question of exposed tendons. A double pedicle flap was delayed since a gauntlet flap could not be



FIG. 7. Case II. Six months later the flap was shifted to permit relaxation of the stump of the little finger. Note that the finger can now be laid straight. There is complete use of the stump.

used because of the position of the injury. The delay was necessary to insure the circulation from one end. Immediate action in covering the denuded area would have saved time and scar formation. The loss of the little finger would have made the hand useless in industry.

CASE III. A white male, age 28, and an electrician, was admitted to the hospital after falling against a high tension wire. His general condition was not very grave and he recovered quickly. There were several areas of burn on his arms and hands. The deepest and largest was on the inner aspect of the left wrist. There was a small area on the right wrist and one in the right

palm. The hands were greatly swollen for two weeks. The skin in the burned areas began to slough and the tendons of the left wrist became exposed. The area was two inches wide and three inches long. The patient was referred to

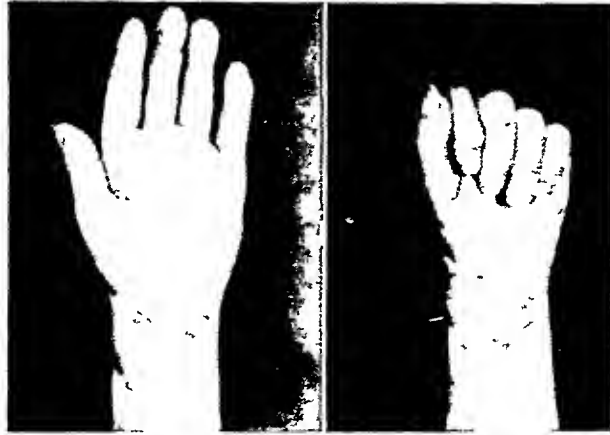


FIG. 8. Case III. A flap had been sutured over the exposed tendons on the inner side of the wrist. Note that the fingers can be flexed completely. There is complete use of the hand with normal function.

us concerning some procedure to save the tendons. A tubed flap was raised on the right abdomen. The tendons were dressed with iodiform gauze which kept them dry and delayed the slough. After two weeks the distal end of the flap was cut and the flap sutured over the denuded tendons. This flap



FIG. 9. Case IV. Claw deformity of the hand due to a loss of tendons in the wrist. The index finger is flexed by a scar band. There is no motion in the wrist. The fingers can be moved.

healed without infection and two weeks later the other end of the flap was sutured into place. The injury had caused the tendons to adhere and massage was started. After six months the tendons moved freely and perfect motion was secured. (Fig. 8.)

Comment. A tubed flap was used because it was most easily utilized. Tubing eliminated any raw areas to invite infection. Here one had to wait until the slough of the burned skin could be removed and there was no way to determine its extent sooner.



FIG. 10. Case iv. Tubed flap raised on the chest and abdominal wall; the tube is two weeks old. A rubber band was placed around the lower end and tied tightly constricting the circulation. The flap was cut on the following day. Note the bleeding from the stump. The rubber band was left on the stump on the abdomen to act as a hemostat.

CASE IV. A white male, age 10, received an electrical burn on the right wrist. He was treated for a long period of time until all of the tendons of the wrist had sloughed and the area had healed. This caused a marked flexion deformity of the hand with no function. (Fig. 9.) The index finger was flexed by a scar band. The scar on the wrist involved all of the tendons on the outer aspect of the palmar surface with a heavy scar attached to the bone. There was no motion at the wrist. He came for treatment eighteen months after the injury. A tubed flap was raised on the right side of the



FIG. 11. Case iv. The flap was sutured into the lower half of the searred area. Two weeks later a rubber band was placed around the distal end of the flap and the flap cut off on the following day. Note the bleeding from the stump. The rubber band was left on the distal end to act as a hemostat.

chest and abdomen. (Fig. 10.) Two weeks after it was formed, a rubber band was tied at the lower end to cut off the circulation gradually. The next day the tube was cut just above the band. The following day the flap was opened along the scar of its formation one third its length and sutured into the wrist after the scar had been partly removed. The lower part of the scar was freed from the bone and cut in strips to simulate tendons. (Fig. 11.) Two weeks later the other end of the tube was severed and the flap opened and inserted into the defect made by removing the remainder of the scar.

The scar band on the index finger was released by a z plastic. (Fig. 12.) The flap healed and the wrist was straight with some function. In an extended position there was some power in the fingers but if the wrist was flexed the



FIG. 12. Case IV. The distal end of the flap had been sutured into the wrist after the remainder of the scar had been removed. The wrist is now mobile. The scar was relaxed on the index finger permitting extension.

power was lost. The scar, acting as a tendon, was not short enough. One year later (Fig. 13) the patient returned. An incision was made near the margin of the flap on the forearm and the muscle bundle exposed. A second incision was made on the wrist where the tendon ends were massed in scar. Strips



FIG. 13. Case IV. The hand one year later. There is flexion at the wrist but the fingers cannot act with the wrist extended. Strips of fascia were laced under the flap and attached to the end of the muscle bundle and the ends of the tendons in the wrist which were massed by scar. c, the wrist was flexed by the fascia to give more power to the fingers. There was an improvement in function.

of fascia lata were taken from the right thigh and the mass of muscle and the tendon ends laced with the wrist in a flexed position. Passive motion was started on the second day after operation and active motion was begun

one week later. The power of the fingers was greatly increased. Function was partly restored.

Comment. The tendons could probably have been saved by a flap before they had sloughed. The replacement of the sear with a bed of fat made it possible to attempt the use of fascia for tendons. The individual finger action could not be attained but a more useful hand was secured. Case 3 would probably have terminated in this fashion.

SUMMARY

It is evident that tendons can be saved by the use of flaps even after they have begun to slough. Skin grafts will not take over exposed tendons and should not be attempted.

In cases where the skin has been injured by pressure, the chances of survival are so remote that valuable time will be saved if no attempt is made to preserve it.

The surgeon must select the type of flap which can be easily used in a given case. In Case I an immediate transfer was possible because a gauntlet flap could be used. In Case II, the flap was delayed because a single pedicle flap was desirable and this type could not be used immediately under the given conditions. In Cases III and IV, a tubed flap was used to avoid exposed granulations and because it insured the best take in the most comfortable position. Flaps from the back are not desirable because of the thickness of the skin and the uncomfortable position into which a patient with a hand injury would have to be placed.

Three cases are presented in which the function of the hands was saved to a degree sufficient to justify the time and trouble required.

In an industrial age in which competition is so great, these patients were re-established sufficiently to permit them to return to employment of some form and to keep them off of the long list of unemployed.

AVULSION OF THE LOWER BICEPS BRACHII TENDON

ANALYSIS OF FIFTY-ONE PREVIOUSLY UNREPORTED CASES

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AVULSION of the tendon of the biceps brachii at its radial insertion is a lesion rarely encountered. Because it occurs more frequently than one is led to believe from the few cases recorded in the surgical literature, and because of the perplexing problem it presents when one is for the first time suddenly and unexpectedly confronted with its repair, it is the purpose of this paper to report in detail two typical cases and add to the literature some fifty-one cases previously unreported, with a brief analysis and discussion pertaining to the diagnosis, operative repair and end results in this interesting condition.

Injuries to the biceps brachii muscle and tendons have up to the present time received scant and casual mention in most of the surgical textbooks. A great deal has been written referring to affections of the tendons of origin, however; and rupture, dislocation and elongation of the long head of this muscle have been frequently reported and discussed.

Gilcreest,¹ in an elaborate and comprehensive review of biceps tendon injury presented before the American College of Surgeons in 1933, analyzed one hundred cases and quoted Bianchieri² as reporting that of the three parts constituting the biceps, the long head is most frequently affected (96 per cent), next the lower tendon (3 per cent), and least of all the short head (1 per cent). At that time Gilcreest was able to find in the available literature only nineteen reported cases of rupture of the lower tendon and added three more from his series. He states that in the lower tendon, rupture usually occurs at or near its insertion into the radius and it would seem from his classified list that the three cases he was adding to the literature were avulsion cases.

In the 1939 *Year Book of General Surgery*, Graham³ states that unlike rupture of the long head of the biceps, avulsion of the distal

¹ GILCREEST. *Surg., Gynec. & Obst.*, 58: 322-337, Feb. 1934.

² BIANCHIERI. *Chir. d. organi di movimento*, 9: 580-588, Bologna, 1925.

³ The *Year Book of General Surgery*. P. 639. Chicago, 1939.

tendon from the radial tubercle is rare, only a dozen or so cases being on record. In my search of the literature, I was able to find only twenty-four cases in which the lower tendon had been completely avulsed from the tuberosity of the radius as demonstrated at operation. They are listed in Table 1 with the name of the surgeon, the method of repair, and the year reported.

The author's attention was called to this interesting lesion when, for the first time and within a period of nine months in 1937 to 1938, two cases were encountered at the Buffalo General Hospital. In each instance a diagnosis of rupture of the distal biceps tendon was made

TABLE 1
CASES OF LOWER BICEPS TENDON AVULSION PREVIOUSLY REPORTED

Surgeon	Method of Dealing with Avulsed Tendon	Reported
1. Aequaviva.....	Direct suture to bicipital tuberosity.	1898
2. Bauman.....	Catgut woven into tendon end. Approximated tendon to radial tubercle. Brought suture ends through counter incision, dorsum forearm and tied them over gauze.	1934
3. Benoiste-Pilloire.....	Calf tendon graft to bicipital tuberosity.	1933
4. Bruning.....	Direct suture to bicipital tuberosity.	1928
5. Ceeoni.....	Direct suture to tuberosity and bicipital fascia.	1930
6. Donlauser and Kenny	Sutured into antibrachial fascia.	1939
7. Guibal and Ortseheit..	Direct suture to bicipital tuberosity.	1930
8. Guibal and Ortseheit..	Sutured to tendon brachialis anticus.	1933
9. Hahn.....	Direct suture to bicipital tuberosity.	1909
10. Jeanneney.....	Direct suture tuberosity and bicipital fascia.	1929
11. Kerschner.....	Nailed tendon to tuberosity.	1928
12. Leavitt and Clements.	Silk and chromic sutures woven into tendon and passed through drill holes in tuberosity and tied.	1935
13. Lyle.....	Braided silk sutures woven into tendon and tied around shaft of radius.	1932
14. Platt.....	Looped through hole drilled in radius.	1931
15. Poli.....	Fastened to radius with loops of silk and kangaroo tendon.	1938
16. Roeder.....	Direct suture to bicipital tuberosity.	1913
17. Röfer.....	Sutured?	1909
18. Rogers.....	By silk sutures through drill holes in tuberosity.	1939
19. Schmieden.....	Sutured to bicipital fascia.	1928
20. Seneque and Berthe..	Sutured to periosteum of bicipital tuberosity.	1935
21. Sonnensehein.....	Attached by means of drill hole and trap door in radius.	1932
22. Stolze.....	Direct suture tuberosity and bicipital fascia.	1928
23. Thomsen.....	Loops of strong silk threaded through tendon and passed through drill holes in tuberosity.	1938
24. Wiesman.....	Direct suture to supinator longus and pronator radii.	1906

preoperatively and avulsion from the radial tubercle was not suspected until demonstrated at operation. (Table 1.)

AUTHOR'S CASE

History of Injury. D. C., male, age 43, was injured February 14, 1938. While moving oxygen tanks, one of them tipped and started to fall. In an attempt to prevent same, he quickly extended his right arm and caught the falling tank on the palm of his right hand. He, at the moment of forceful impact, felt a sudden "electric-like shock shoot up his entire right arm." He continued working though he observed considerable weakness and loss of power in the arm. Pain was not marked.

Examination. An examination was made twenty-four hours later. He complained of weakness, soreness and tenderness throughout the right forearm and arm. There was extensive ecchymosis on the anterior surface of the lower arm, throughout the antecubital fossa and extending down the ulnar half of the forearm. The antecubital fossa was moderately swollen and tender. Though one could not see the biceps tendon because of the swelling, it could be felt. It could not be made taut by active contraction of the biceps muscles, however. On comparing the two arms there was an obvious defect in the right, in that the belly of the biceps on contraction was located at a higher level. Flexion of the forearm, though comparatively weakened, caused little discomfort. It was thought that the power of supination was probably diminished. Diagnosis of rupture of the lower tendon of the biceps was made.

Operation. Operation was performed on February 21, 1938, the seventh day post-trauma, by the author. The incision extended obliquely across the right antecubital fossa. The median basilic vein was divided between ligatures. Fascia which was hemorrhagic was incised. The bicipital fascia which was hemorrhagic and edematous appeared to be intact. The biceps tendon, which had been avulsed from the radial tubercle, was lying quite free and loose between the brachioradialis muscle laterally and the pronator radii teres muscle medially. Its bulbous end appeared frayed and edematous. There was a small blood clot immediately beneath it. Considerable time was spent in trying to expose the tuberosity of the radius, which was unsuccessful and finally abandoned. The operator was impressed with the numerous important structures identified and confined in this anatomical region and was thoroughly convinced that exposure of the tubercle by this approach was both impractical and unwise. It seemed important that the power of supination be preserved even though it were only an accessory function of the biceps. This seemed to demand reattachment to the radius. On the other hand, it was recalled how difficult it was to determine definitely any loss of supinative power in the patient preoperatively and because of the apparent inaccessibility of the radial tubercle, it was decided to splice the biceps tendon into the well defined tendon of the

brachialis anticus muscle at its insertion into the base of the coronoid process of the ulna.

Repair was finally accomplished by splitting the tendon of the biceps in

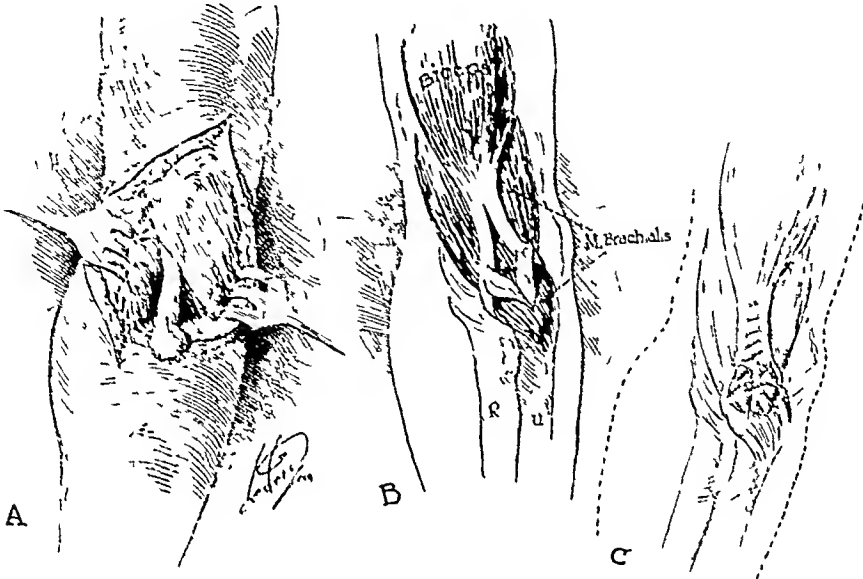


FIG. 1. Author's case. Method of repair. A, avulsed tendon end lying in operative field; B, tendon split and carried around and up through the tendon of the brachialis muscle at its insertion; C, splicing completed as shown with interrupted silk and chromic gut sutures.

a vertical plane and inserting these two halves of the tendon around and up through the tendon of the brachialis anticus muscle, immediately proximal to its insertion into the base of the coronoid process of the ulna. These two loops of the split biceps tendon were completed, fastened together and to the brachialis tendon as well, with interrupted chromic and silk sutures. The wound was then closed and a molded posterior plaster splint was applied with elbow fixed in right angle flexion. (Fig. 1.)

Postoperative Care. The splint was removed on the eleventh postoperative day at which time a sling was furnished and the patient was discharged from the hospital. There was at this time a noticeable small localized area of tender induration at the site of the tendon splicing.

He returned to light work March 23, 1938, the thirtieth postoperative day, and returned to his usual work April 25, 1938, two months postoperatively.

A note two months after operation stated that he was working steadily without complaint. His arm looked good. There was practically full range of motion. Power of flexion was good. Extension was still limited by 10 degrees. It was believed that power of supination was diminished but the extent of loss could not be estimated.

One year after injury function was completely restored as far as could be determined. Flexion power was normal as compared to the uninjured arm.

There was no objective dislocation of the contracted biceps belly and supinative power, though difficult to estimate, also appeared to be equal to that of the uninjured extremity. With the forearm flexed or extended, the patient could turn in supination and pronation, an eight pound Stillson wrench requiring torsion power of thirty-six pounds. He could do no better with the uninjured arm.

CASE OF DR. W. W. PLUMMER

History of Injury. Dr. E. K., male, age 62, was injured June 21, 1937. While attempting to disengage his automobile bumper, which was interlocked with that of another car, he lifted suddenly and forcefully. He suffered severe pain in the lower right arm and forearm which was accompanied by a sensation of bursting which "seemed as though a tendon had ruptured." The severe pain was only momentary, he was able to move his arm and forearm, and other than noticeable weakness and tenderness to touch about the anterior surface of the elbow there was little discomfort.

Examination. The patient was examined on June 22, 1937, twenty-four hours later. The right forearm could be actively flexed almost completely but only with considerable pain. Power of flexion was noted to be greatly diminished. There was no marked swelling and no discoloration. There was an abnormal fullness on the medial aspect of the anticubital fossa. The outstanding objective sign was the position assumed by the actively contracted belly of the biceps muscle which was at a considerably higher level as compared to the left or uninjured arm. The lower tendon could not be identified. Diagnosis of ruptured distal tendon of the biceps was made.

Operation. Operation was performed on June 23, 1937, forty-eight hours post-trauma, by Dr. W. W. Plummer. A midline vertical incision was made across the anticubital fossa, and the fascia was incised. There was no subcutaneous hemorrhage. The bicipital fascia was intact. The biceps tendon appeared normal in all respects except that it seemed to be slack. Exposure and inspection of the tendon distal to its muscle expansion revealed nothing abnormal. However, when during inspection the tendon was lifted, the entire distal end suddenly and unexpectedly slipped out of its canal into the wound. It was observed that attached to the bulbous end there was a thin osseous flake which was presumed to come from the bicipital tuberosity. The operator was astonished. It seemed impractical to attempt exposure of the radial tubercle with its hazardous dissection. It was therefore planned to pull the tendon back through the canal and attempt to oppose it in its normal relation to the radius. This was accomplished by inserting a blunt instrument into the canal from which the tendon had been withdrawn. An incision was then made immediately over the point of the instrument on the dorsal surface of the forearm. This smaller incision was then enlarged to permit protrusion of the instrument and exposure of the adjacent ulnar shaft. Two small holes were drilled in the ulnar shaft and a

mattress suture of ox fascia, which had been previously attached to the tendon end, was guided through the canal and out through this dorsal incision. The loose ends of the ox fascia were then passed through the two

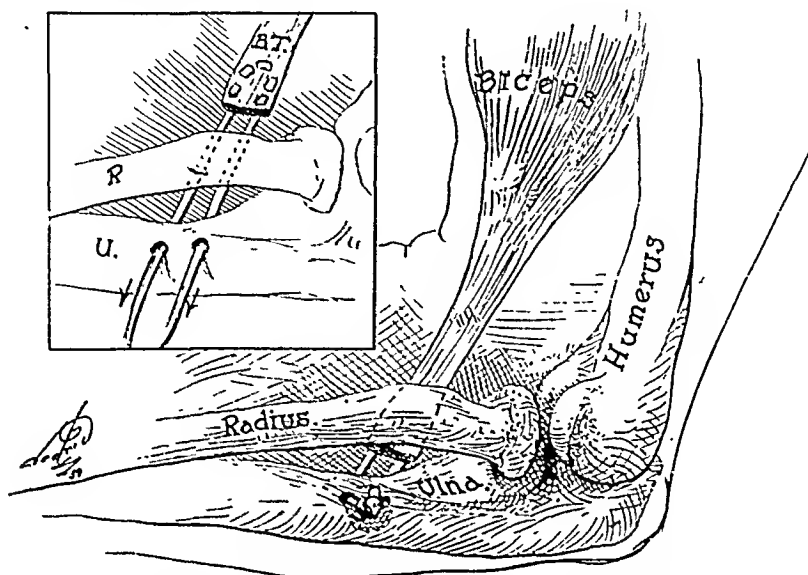


FIG. 2. Case of W. W. Plummer. Method of repair. Ox fascia woven into end of biceps tendon as shown in insert. Tendon approximated to ulna shaft adjacent to bicipital tuberosity by means of drill holes. (Counter incision over ulna required.)

holes in the ulna and the attached distal tendon of the biceps drawn back into its canal in such fashion as to oppose probably its avulsed surface to the site of the radial tubercle. The two ends of the ox fascia were then tied together over the ulna and the wounds were closed. The arm was then placed in a lateral moulded plaster splint with elbow in 90 degrees flexion. (Fig. 2.)

Postoperative Care. The patient was discharged from the hospital on the third day. Fixation dressing was removed at the end of one month after which function was resumed. Restoration of function was progressive and satisfactory and eventually complete.

These two cases were informally presented, shown and discussed at the meeting of the American Orthopedic Association held in Buffalo, New York, June, 1939. Following the presentation, several members mentioned cases they had treated and how repair was accomplished. From this experience and in spite of the fact that so few cases had been reported in the literature, it seemed that this lesion probably occurred more frequently than the reports would indicate or suggest.

When for the first time, one unexpectedly encounters this unusual condition in the operating room; he is obliged to resort to his own

ingenuity and it is, therefore, not surprising that the previously described methods of repair differ greatly. It is surprising and noteworthy, however, that the end results as reported were equally satisfactory and for the most part excellent in all cases, regardless of the method of repair.

This fact was so impressing that it occurred to the author that it would be desirable and worthwhile if a considerable number of cases could be collected and analyzed with the hope of establishing some precedent which might be used for the guidance of others called upon to care for this lesion.

It was believed that it might be possible to uncover unreported cases through correspondence with a group of qualified men distributed throughout the country.

In July, 1939, letters of inquiry were sent to the members of the American Surgical Association, The American Orthopedic Association and the American Association for the Surgery of Trauma. The response was most gratifying as shown in Table II.

TABLE II

	In- quiries	Replies	Per Cent	Cases
American Surgical Association	146	108	73 9	2
American Orthopedic Association	130	86	66 1	11
American Association for the Surgery of Trauma	191	141	73 8	23
Special references	23	20	87 0	15
Total	490	355	72 6	51

The correspondents were, almost without exception, most gracious and generous in furnishing me with data pertaining to their own cases, and many referred me to colleagues or associates who had encountered and operated upon this lesion.

As the result of their great kindness, it is possible to record and briefly analyze fifty-one cases of lower biceps tendon avulsion from the bicipital tuberosity of the radius.

Only those cases which presented unquestionable evidence of complete tendon avulsion as demonstrated at operation are included. In these cases the operator specifically described avulsion and in many instances commented upon the "frayed bulbous tendon end," "periosteal flecks or plaques in the tendon end," or mentioned avulsion with the "bicipital tuberosity remaining clean except for a fringe of tendon remnant along the posterior edge of the tuberosity."

TABLE III
FIFTY-ONE CASES OF LOWER BICEPS TENDON AVULSION PREVIOUSLY UNREPORTED

No.	Case of Dr.	Year	Sex	Age	Technic of Operative Repair	Result
1.	Aitken, A. P.....		M	60	Suturing biceps tendon to tendon of brachialis anticus muscle.	Excellent
2.	Andrews, B.....	34	M	45	Biceps tendon looped through brachioradialis muscle.	Excellent
3.	Badgley, C. and Mitchell, C. L.....	30	M	45	Biceps tendon sutured to tendon of brachialis anticus muscle.	Excellent
4.	Bates, W.....	21	M	38	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity. (Chromic gut.)	Good
5.	Bates, W.....	34	M	45	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity. (Chromic gut.)	
6.	Bates, W.....	39	M	45	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity.	Good
7.	Buckner, H.....				Fascial graft looped around neck of radius and sutured to biceps muscle.	Good
8.	Bunnell, S.....	28	M	59	Fascial graft through drill hole in bicipital tuberosity.	Good
9.	Bunnell, S.....	30	M	35	Drill holes bicipital tuberosity. (Silk.)	Excellent
10.	Bunnell, S.....	32	M	52	Drill holes bicipital tuberosity. (Silk.)	Excellent
11.	Coley, B.....				Drill holes bicipital tuberosity. (Silk.)	Excellent
12.	Coley, B.....				Biceps sutured to tendon fringe on bicipital tuberosity.	Excellent
13.	Dobbie, R. P.*...	38	M	43	Tendon split and spliced into tendon of brachialis anticus muscle. (Chromic gut and silk.)	Excellent
14.	Dudley, H.....				Tendon biceps split, part sutured to subperiosteal bed in bicipital tuberosity, other part looped around radius and sutured to self.	Good
15.	Gallie, W. E.....	34	M		Fascial graft looped around shaft radius.	Excellent
16.	Gallie, W. E.....	36	M		Fascial graft through drill hole bicipital tuberosity.	Excellent
17.	Gallie, W. E.....	38	M		Semitenonosus graft through drill hole bicipital tuberosity.	Excellent

TABLE III. (Continued)

No.	Case of Dr.	Year	Sex	Age	Technic of Operative Repair	Result
18.	Ghormley, R. ...	38	M	49	Drill holes bicipital tuberosity. (Fishline.)	Excellent
19.	Grace, R. V.	37	M	50	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity. (Silk.)	Excellent
20.	Hammond, R.	35	M	46	Mattress chromic suture, connecting tendon to frayed tendon remnant attached to bicipital tuberosity.	Good
21.	Hawkins, T.		M		Drill holes bicipital tuberosity. (Silk.)	Good
22.	Hedrick, D. and Mitchell, C. L.	37	M	48	Biceps tendon sutured to fascia of brachialis anticus. (Silk.)	Good
23.	Henry, M. O.				Drill holes bicipital tuberosity. (Chromic cat gut.)	
24.	Howard, N.	35	M	35	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity. (Silk and periosteum.)	Excellent
25.	Landenberger, J.				Drill holes bicipital tuberosity. (Chromic gut.)	Excellent
26.	Landenberger, J.				Drill holes bicipital tuberosity. (Chromic gut.)	Excellent
27.	Leavitt and King	36	M	60	Drill holes bicipital tuberosity. (Chromic gut.)	Excellent
28.	Marble, H. C.		M	70	Biceps tendon sutured to frayed tendon remnants on bicipital tuberosity. (Silk.)	
29.	Marble, H. D.		M		Fascial graft looped around neck radius.	
30.	McGaw, W. H.	37	M	44	Fascial graft, drill holes bicipital tuberosity (Silk.)	Good
31.	Moore, J. R.	39	M	52	Biceps tendon sutured to lacertus fibrosus and brachialis anticus muscle.	Too early to state
32.	Morrison, G.		M	62	Biceps tendon passed through lacertus fibrosus and sutured to self.	Excellent
33.	Nachlas, I. W.		M		Biceps tendon sutured to adjacent fascia.	Excellent
34.	Olson, F. A.	37	M	39	Drill holes, bicipital tuberosity silver wire loop.	Good
35.	Patton, C. L.	31	M	61	Drill holes bicipital tuberosity. (Chromic gut.)	Excellent
36.	Perkins, R. S. .	38	M	45	Drill hole bicipital tuberosity. (Silk.)	Fair

TABLE III. (Continued)

No.	Case of Dr.	Year	Sex	Age	Technic of Operative Repair	Result
37.	Perkins, R. S.....	39	M	41	Drill hole bicipital tuberosity. (Silk.)	Excellent
38.	Plummer, W. W.*.	37	M	62	Biceps tendon attached to ulna opposite bicipital tuberosity by means of drill holes and ox fascia.	Excellent
39.	Porter, E. M.....				Sufficient fringe on tubercle, reattachment tendon by heavy silk sutures.	Excellent
40.	Rogers, W. A.....		M		Fascia graft through drill hole bicipital tuberosity.	Excellent
41.	Sherrill, J. and Conwell, H. E....	39	M	60	Drill holes bicipital tuberosity. (Silk.)	Good
42.	Smith, M.....	32	M	45	Drill holes bicipital tuberosity. (Silk.)	Excellent
43.	Sonnenschein, H..	33	M	50	Tendon looped through slot in bicipital tuberosity.	Excellent
44.	Sonnenschein, H..	34	M	56	Tendon looped through slot in bicipital tuberosity.	Excellent
45.	Strickler, F.....	33	M	50	Fascial graft, drill holes bicipital tuberosity. (Chromic gut.)	Excellent
46.	Sweeney, H.....	36	M	57	Biceps tendon sutured to frayed tendon remnants on tubercle and lacertus fibrosus.	Good
47.	Venable, C.....				Drill hole in radius and suture.	Excellent
48.	Wiley, E. H.....	16			Reattachment bicipital tuberosity. (Chromic gut.)	Excellent
49.	Williamson, E.....	38	M	67	Biceps tendon sutured to adjacent muscle and lacertus fibrosus.	Too early to state
50.	Wilson, P. D.....		M		Fascial graft, drill holes bicipital tuberosity.	Excellent
51.	Wyckoff, H. and Maxson, F.....	38	M		Fascial graft, tunnel in bicipital tuberosity.	Excellent

* Case report in detail in this paper.

Cases reported as being ruptured close to or proximal to the bicipital tuberosity were excluded, as were several cases associated with or complicated by fractures. Several cases reported, presented typical history, signs and symptoms but were excluded because they were not operated.

The cases reported in Table III have never been previously recorded in the literature. Operator, method of repair, year, sex, age

and end results are the essential data which space will permit recording.

Considerable more data are available than was displayed in the preceding tabular outline of cases and follow:

Sex Incidence. In all cases where sex was mentioned (forty-one) the injured was a male. This is also true in all cases previously reported in the literature.

Age Incidence. There were thirty two cases in which the age was stated. The oldest, seventy, the youngest, thirty-five, the average age was fifty-one.

Arm Affected. The arm (right or left) was stated in only twenty-six of the fifty-one cases. Of these, the lesion was seen in the right arm twenty-one times, in the left arm five times. It seemed for the most part to depend on whether the individual was right or left handed.

Indirect Violence. In all cases in which the nature or mechanism of the trauma was furnished, violence was indirect in type. Considerable extension force suddenly applied to a resisting, actively flexed forearm was almost invariably described. The mechanisms more frequently mentioned included lifting, pulling and straining at heavy objects, cranking automobiles, catching another falling person or object of considerable weight, attempting to break fall by grasping at passing objects, lifting ends of automobiles in an effort to disengage entangled bumpers, etc.

In discussing the exciting cause of this uncommon lesion, it should be stated that of the cases here reported five patients were physicians. The violence described in these physicians is typical as well as interesting and follows:

Case 18 was lifting the front end of an automobile.

Case 38 was lifting on front bumper of automobile.

Case 41 made a playful pass at daughter's "rear end," and was said to have missed.

Case 46 was cranking automobile.

Case 50 was delivering obstetrical case with forceps.

DIAGNOSTIC FEATURES

Though it is not possible to differentiate preoperatively between avulsion of the tendon from the bicipital tuberosity of the radius, and rupture of the tendon proximal to its radial insertion, it should be recognized that either may occur and both require surgical repair.

Loss in continuity of the tendon is all that one can be expected to appreciate and this is not difficult.

Not a few of the patients reported to the surgeon that they thought they had "torn or ripped a tendon or muscle." As one might expect, the subjective complaints varied considerably with the individual and the time elapsed since injury, but several were conspicuously constant.

SUBJECTIVE COMPLAINTS

1. Tearing sensation in the lower arm or upper forearm (region anterior elbow) at the time of violence.
2. At time of violence, sudden pain of short duration (usually not marked).
3. Varying degrees of disability (usually considerable) as manifested chiefly in complaint of diminished power of forearm flexion, and also to a lesser degree, diminished power of supination.
4. Soreness in lower arm and upper forearm (anticubital fossa) during the first few days immediately following injury.

OBJECTIVE SIGNS

The objective signs are unmistakable and diagnostic. It must be remembered that variations are to be expected, dependent upon the type of individual, muscular development, and length of time between trauma and examination. In general, and as a rule, the following signs are to be expected and were observed:

1. Swelling, tenderness and ecchymosis in the anticubital region (early).
2. Gross, definite weakness in power of flexion, and to a lesser degree supination. It is to be remembered that flexion is possible and often complete, and though often painful, is not necessarily so; also that it may be difficult or impossible to demonstrate any loss in supinative power.
3. The belly of the contracted biceps muscle is more prominent and retracts to a higher level in the affected arm. This is usually quite striking.
4. The biceps tendon and the lacertus fibrosus, which when the forearm is flexed, are normally palpable and tense, are, in the injured arm, slack and difficult or impossible to identify definitely.
5. There is a visible and palpable depression or defect in the anticubital fossa where the normal tense tendon and fascia should be.

OPERATIVE FINDINGS

In almost all instances the preoperative diagnosis was rupture of the distal biceps tendon. As previously mentioned, one readily recognizes a disruption in the continuity of the tendon, but unless avulsion has been previously encountered, it is not anticipated. These fifty-one cases were operated upon by forty surgeons and only eight of these surgeons have encountered the condition more than once. Bates, Bunnell, Gallie and Sonnenschein have each operated this lesion three times; Coley, Landenberger, Marble and Perkins, two times.

The cases previously reported in the literature are few and for the most part foreign, so it is not surprising that most of the operators were astonished to find an avulsed tendon and a clean bicipital tuberosity rather than a tendon lacerated or ruptured proximal to its insertion.

A quite different and more difficult problem presents itself when, instead of being able to suture the adjacent lacerated ends of a good-sized superficial tendon, it becomes necessary or seems desirable to secure reattachment of the tendon to the radius, the adequate exposure of which is difficult and not without danger.

In about 25 per cent of these cases, considerable time elapsed before operation (several weeks to several months). The description as to the appearance and state of the tissues and structures naturally varied accordingly.

Hemorrhage was as a rule not extensive or marked. In most cases it was described as slight, in a few, marked or entirely absent.

Bicipital Fascia (lacertus fibrosus). In most cases it appeared to be intact, in many others it was lacerated in varying degrees.

Biceps Tendon. The description of its appearance and position varied considerably. In all cases it was described as having been completely avulsed from the bicipital tuberosity of the radius. A bulbous, expanded, distal end, showing interlacing tendinous fibers and occasional flecks or plaques of bone and periosteum was frequently mentioned.

In many instances the position of the tendon appeared to be normal except that it was observed to be slack.* Dr. Plummer's description is more or less typical and was repeated many times as the finding in these cases. Where little or no displacement of the tendon was observed the bicipital fascia was noted to be intact. On

* See detail case report.

the other hand, marked retraction of the tendon upward into the lower arm was also frequently observed and the tendon was described as being coiled upon itself at various levels in the arm. This almost invariably occurred in those cases in which the lacertus fibrosus had been lacerated and considerable time had elapsed before operation. It was in these cases, in which upward retraction of the tendon was marked and considerable time had elapsed, that fascial and tendinous grafts were utilized in securing reattachment to the radius.

Bicipital Tuberosity of the Radius. The distal tendon of the biceps is normally inserted into the posterior border of the bicipital tuberosity. Most of the operators commented upon the completeness of the avulsion and the clean appearance of the remaining tuberosity. Others described frayed tendon fringe or remnants remaining along the posterior margin or ridge of the tubercle. In some instances this apparently permitted or aided direct suture, e.g., Cases 4, 5, 6, 12, 18, 19, 23, 27, 38, 45, 47. Still others, because of the appearance of the distal end of the tendon, assumed the tubercle to be clean and in view of the method of repair, did not expose or inspect the tubercle, e.g., Cases 1, 2, 3, 13, 22, 31, 32, 33, 38, 49.

OPERATIVE REPAIR

Incision was invariably in the anticubital region, vertically or obliquely placed and extending for varying distances upward on the arm and downward to the forearm. In only three instances, an additional smaller incision was made over the lateral or dorsal surface of the upper forearm to facilitate exposure of, and work on the bicipital tuberosity, e.g., Cases 16, 38, 48.

When one identifies in the field of operation the avulsed tendon end, it immediately occurs to him that it is most desirable to reattach the tendon to its original point of insertion, the bicipital tuberosity of the radius. He recalls that the biceps is the most efficient flexor of the forearm and that it is also a powerful supinator. To re-establish these functions seems imperative, and an effort is made to expose the tubercle. This is not easy. One only has to review the anatomy of this region to appreciate its depth, and the many important structures it is necessary to expose and identify and, at the same time, protect from injury. It is surprising and impressive to see in such a small field, so many structures, the injury of any one of which might cause serious complications and permanent disability greater than that which is being relieved.

In the series of twenty-four previously reported cases (Table I) as well as the series of fifty-one previously unreported cases (Table III), many different methods of accomplishing repair are described. They all fall into one of two major groups, however, depending on whether the tendon was attached to the radius or to other structures in the upper forearm.

Of the twenty-four previously reported cases, in twenty or 83 per cent, the tendon was reattached to the radius, which required exposure of the bicipital tuberosity. In four cases or 17 per cent, the bicipital tuberosity was not exposed but instead the tendon was attached to structures in the forearm other than the radius.

METHOD OF REPAIR TWENTY-FOUR CASES PREVIOUSLY REPORTED (TABLE I)

Direct attachment to the radius: twenty cases or 83 per cent.

1. 8 cases—Tendon attached directly to the bicipital tuberosity by suturing to periosteum and frayed tendon fringe remaining on the tubercle. Cases: 1, 3, 4, 7, 9, 16, 17, 20.
2. 3 cases—Tendon attached directly to the bicipital tuberosity by suturing to periosteum and frayed tendon fringe remaining on the tubercle and additional suture to the bicipital fascia. Cases: 5, 10, 22.
3. 5 cases—Tendon attached to bicipital tuberosity by means of drill holes and suture material. Cases: 12, 14, 18, 21, 23.
4. 2 cases—Tendon tied around radius by means of attached sutures. Cases: 13, 15.
5. 1 case—Tendon nailed to radius. Case: 11.
6. 1 case—Tendon held opposed to bicipital tuberosity by means of suture transfixing forearm. Case: 2.

Attachment to structures in the forearm other than radius: four cases or 17 per cent.

7. 4 cases—Tendon sutured to bicipital fascia. Cases: 1, 6. Tendon sutured to brachialis anticus. Case: 8. Tendon sutured to brachioradialis and pronator radii teres. Case: 24.

The end result in all of these cases was invariably reported as good or excellent, and regardless of the operative procedure, it was stated or inferred that loss of function was nil or negligible. No complications were recorded.

Upon analysis of the fifty-one cases in the present series, similar end results were observed.

In forty-one cases or 80 per cent the tendon was reattached to the radius and in most instances to the bicipital tuberosity. Drill holes, slots, loops, grafts of fascia or tendon and various suture materials were described as being used.

In ten cases or 20 per cent the bicipital tuberosity was not exposed, and repair was accomplished by attachment of the tendon to structures other than the radius. Summary of methods of repair follows:

METHOD OF REPAIR IN FIFTY-ONE CASES PRESENT SERIES
(TABLE III)

Direct attachment to radius: forty-one cases or 80 per cent.

1. 16 cases—Tendon attached to bicipital tuberosity by means of drill holes and suture material. Cases: 9, 10, 11, 18, 21, 23, 25, 26, 27, 34, 35, 36, 37, 41, 42, 47. Suture material: silk seven cases, chromic gut five cases, wire and fishline one case each, material not stated in two cases.
2. 11 cases—Fascial graft woven into or sutured to tendon which was then:
 - (a) passed through hole or holes drilled in bicipital tuberosity. Cases: 8, 16, 30, 40, 45, 50, 51.
 - (b) looped around upper third of radius. Cases: 7, 15, 29.
 - (c) semitendonosus graft woven into biceps tendon, passed through drill hole in bicipital tuberosity and knotted. Case: 17.
3. 11 cases—Tendon attached to bicipital tuberosity by suturing to periosteum and frayed tendon fringe remaining on tubercle. Cases: 4, 5, 6, 12, 19, 20, 24, 28, 39, 46, 48. Suture material: silk seven cases, chromic gut four cases.
4. 2 cases—Tendon looped through slot in tuberosity. Cases: 43, 44.
5. 1 case—Tendon of biceps split. Part sutured to subperiosteal bed in bicipital tuberosity, other part of tendon looped around radius and fastened to self. Case: 14.

Attachment to structures in forearm other than radius: ten cases or 20 per cent.

6. 4 cases—Tendon sutured to or into tendon of brachialis anticus muscle. Cases: 1, 3, 13, 22.
7. 4 cases—Tendon sutured to or looped through lacertus fibrosus. Cases: 31, 32, 33, 49.

8. 1 case—Tendon looped through brachioradialis muscle. Case: 2.

9. 1 case—Tendon attached to ulna opposite bicipital tuberosity by means of drill holes and ox fascia. Case: 38.

In forty-one or 80 per cent of these cases the bicipital tuberosity was exposed.

In twenty-six or 50 per cent drill holes, slots or tunnels were said to have been inserted in the tuberosity to facilitate attachment of the tendon. As mentioned, to expose and drill the tuberosity requires a skillful bit of dissection and a fair knowledge of anatomy. It is surprising the number of times this method was chosen and performed and it is most creditable that complications were reported to follow this procedure on only three occasions. McGaw (30), reported postoperative radial nerve palsy in his case, but recovery of nerve function was said to be complete within six weeks and final end result was recorded as good. Sherrill and Conwell (41), reported radial nerve palsy subsequent to operation, which still existed after fifteen months in spite of recent unsuccessful surgical attempt at correction. As is so often the case, this single instance of serious disability would and did occur in a surgeon. Perkins (36), reported that his patient subsequently developed myositis ossificans with considerable disability about the elbow joint which accounts for the only "fair" end result reported in the entire group of cases.

With all due respect for the ability of this group of prominent and capable surgeons, it seems that for the most part they were endowed with considerable good fortune and it would perhaps not be amiss to venture the guess that in many instances relief was felt and expressed when, the day after operation, examination revealed normal sensory and motor innervation.

In the ten cases in which the bicipital tuberosity was not exposed, it was of course necessary to reattach the tendon of the biceps to structures other than the radius. In all but one instance (Case 38) this was accomplished by utilizing adjacent soft parts. In these few cases there were, as might be expected, no complications reported and the functional end result as reported was equally as good as in those cases in which the tendon was reattached to the radius.

POSTOPERATIVE TREATMENT

The postoperative care was with slight variation quite similar in the great majority of cases. Immobilization was accomplished by

means of a molded plaster splint, arm and forearm included. Forearm was held in 90 degrees flexion and though it was not stated whether the forearm was in supinated, pronated or neutral position, it would seem as though the supinated or neutral positions were more desirable in order to lessen the tension and pull of the biceps tendon during the healing period.

The period of immobilization ranged from seven days to six weeks, after which active use and motion were permitted and encouraged. The patients as a rule recovered function progressively and rapidly and with few exceptions returned to work at a relatively early date. It was frequently reported that full or practically full function was restored within a period of three months. Complete extension seemed to be the last function obtained in most instances.

At the end of a year it was difficult to detect any residual disability and were it not for the scar of operation, this would often be impossible.

END RESULTS IN FIFTY-ONE PATIENTS OPERATED UPON

In six of the fifty-one cases the end result was not stated, either because not sufficient time had elapsed for estimation or because the available notes did not record the end results. In only one instance was the result recorded as "fair" and in all others (forty-four cases) it was recorded as "excellent" or "good."

It is appreciated that these terms are not specific or particularly satisfactory when describing end results, but it is to be assumed from the comments furnished by the individual surgeons reporting their

TABLE IV
REPORTED END RESULTS (FORTY-FIVE CASES)

Type of Repair	Total Cases	Excellent		Good		Fair	
		Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Group 1. Cases in which repair required exposure of the bicipital tuberosity. (3 complications)...	37	25	67.5	11	29.7	1	2.7
Group 2. Cases repaired without the exposure of the bicipital tuberosity. (no complications)...	8	7	87.5	1	12.5	0	
Combined Groups 1 and 2. All cases regardless of the method of repair.	45	32	71.1	12	26.6	1	2.2

44 cases or 97.7 per cent excellent or good restoration of function.

eases that the descriptive term "excellent" was used when function (power and range of motion) was fully restored. The term "good" was used when the patient was restored to a degree of economic usefulness equal to that enjoyed prior to injury, and where disability was recorded as being negligible or less than 10 per cent. (Table iv.)

DISCUSSION AND COMPARISON OF END RESULTS ACCORDING TO METHOD OF REPAIR

It is obvious that the main function of the biceps is forearm flexion and this was completely restored in all but one case. *This single exception developed myositis ossificans subsequent to injury and operation. In two other cases complicated by postoperative nerve palsy, the restoration of function was specifically described as good in spite of nerve complication.* Loss of this main function, whether it be in power or range of motion, is easily demonstrated and estimated. In this group of cases, preoperative loss in flexion power was constant and outstanding. At the same time it was observed that loss in power of supination was in no way as constant or conspicuous and in the author's case, reported in detail, though biceps supinative power was known to be lost, it was impossible to demonstrate definitely its absence, either pre- or postoperatively. It seems that this can be logically accounted for in that the lesion occurs in middle aged and elderly, muscular males, and well developed forearm muscles readily compensate for any loss in biceps supinative power. These observations are significant as it becomes apparent that the supinative power of the biceps is of secondary importance and that the primary objective of repair should be the restoration of flexion power.

In reviewing the end results said to have been obtained in the twenty-four previously reported cases, and the fifty-one cases of this series, seventy-five in all, it appears to have been shown that equally effective and satisfactory functional recovery is obtained when the tendon is attached to either the radius or the adjacent upper forearm soft parts. It follows, therefore, that direct reattachment of the tendon to the radius is unnecessary. In the group of forty-one cases of this series, in which reattachment to the radius was accomplished, complications causing serious permanent disability occurred twice (4.8 per cent). This fact suggests that in addition to being unnecessary, it is perhaps impractical and unwise to select a procedure more difficult, dangerous and time consuming when the same result can be obtained with less effort and without the asso-

ciated risk of serious complication, which attends exposure of the bicipital tuberosity when approached through the antecubital fossa.

CONCLUSION

1. Avulsion of the lower tendon of the biceps brachii from its insertion into the bicipital tuberosity of the radius, though uncommon, is not as rare as is suggested by the few recorded case reports.

2. The history of injury, subjective symptoms and objective signs are quite constant and diagnostic.

3. The lesion is disabling and requires operative repair. Many methods have been used and all seem to result in satisfactory restoration of function.

4. Repair of this condition, when unexpectedly encountered for the first time is a perplexing problem to the surgeon because of the desire to restore supinative as well as flexion power. Loss in power of forearm flexion is the outstanding complaint and disability and the chief objective of operative repair should be its restoration. The supinative power of the biceps is of secondary importance and can be ignored, for when it is lost, it is adequately compensated for by the muscles of the forearm.

5. Direct reattachment of the tendon to the upper radius is difficult to accomplish, time consuming and not without danger.

6. Other methods of repair less difficult and dangerous are equally effective and reported end results justify their use.

SUMMARY

1. Twenty-four previously reported cases of lower biceps tendon avulsion are reviewed and fifty-one additional cases as reported by forty surgeons, are analyzed and added to the literature.

2. Two of these cases are reported in detail because they are typical and the methods of repair used are in addition to being unique, simple and satisfactory.

3. The mechanism of injury, diagnostic features, operative findings and methods of repair are described and discussed.

4. Attention is called to the dangers and complications associated with exposure of the bicipital tuberosity.

5. End results are evaluated and compared.

6. Simpler methods of reattaching the tendon to forearm soft part structures are recommended.

This presentation was made possible through the kindness and help of many individuals. The author is indebted to the forty surgeons listed, who

so kindly placed their experiences at his disposal, to Dr. Plummer in particular for his detail case report and drawing, and to the many others unlisted who were kind enough to respond so graciously to his inquiries.

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BILATERAL, INDEPENDENT RUPTURE OF THE LONG HEAD DIVISION OF THE BICEPS BRACHII

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THE purpose of this short communication is four-fold: (1) A *coup d'oeil* of the literature indicates that bilateral, independent rupture of the biceps is almost unknown. (2) Rupture of a muscle or tendon is a distinct entity produced by overwrought muscular contraction. Ruptures of muscles and tendons are not associated with blows, contusions, or open wounds. For example, Lecène and Moulouguet,⁶ writing in *Précis de Pathologie Chirurgicale*, say that "one must reserve the name of muscular rupture to the solution of continuity of the muscle produced in the course and under the influence of contraction." They quote Lejars as supporting the same opinion. In a following statement they say, in effect, that one thus eliminates from the group of true muscular ruptures those that are associated with direct injury, like blows upon a contracted muscle, the latter placing the injury in the category of contusions, and being, at the same time, "veritable fractures of the muscle." (3) Advanced age, with sclerosis, and other senile changes may be regarded as predisposing causes, but not as active concomitant causes. (4) It is believed by the reporter that a substandard physique in the case of a young individual, essentially normal in every respect, may exert a tremendously important etiological influence. This is illustrated by the following report:

A young man, thirty-one years of age, consulted us on December 13, 1934. He complained of weakness, discomfort and awkwardness of both arms, with an enlargement in the front lower brachial region on each side.

According to the history, he was shoveling wheat into a truck one and one-half years before we saw him, and while engaged in that occupation there was sudden, mild, cramping pain in the lower part of the front of the left upper arm, and quickly after that the appearance of a mass about the size of an ordinary egg in the left lower brachial region. The arm was weak, and he was uncomfortable. There was no history of a "snap" at the time

* Dr. Long passed away on October 27, 1940.

of the injury. Regardless of his discomfort, he continued to work as a trucker, taking part in the loading and unloading of the truck.

The general health had always been good. Physically, he was a very small man. The height was $62\frac{1}{2}$ inches, weight 137 pounds. In general, the muscular system appeared to be well developed for an individual of his size. Continuing to work as a trucker, he was greatly annoyed by the weakness of the left arm, and the enlargement which was always present.

About six or eight months after the difficulty in the left arm had developed, he was handling and hauling sand, and about that time an enlargement appeared on the front part of the lower right upper arm. He was under the impression that it had appeared rather slowly, but the enlargement was persistent, and there was weakness and general disability of the right arm.

Examination of the left arm showed a prominent, rather firm enlargement about $2\frac{1}{2}$ inches in diameter on the front part of the lower left upper arm. When the arm was flexed against resistance, this mass became more tense and somewhat larger. It appeared to be distinctly circumscribed. Its contour was not entirely regular, there being a small depression between the outer side and the inner side of the mass. The mass on the outer side appeared to be a good deal smaller than that on the inner side. There was a slight depression in the front part of the left upper arm just above the mass. In examining the patient, it was believed that the tendon of the long head of the biceps could be palpated when the arm was flexed and extended.

In the front of the right lower upper arm there was a similar mass, but a good deal larger than that on the left. This mass in the right arm measured about $3\frac{1}{2}$ by $3\frac{1}{2}$ inches. It was rather soft when the arm was at rest, but became more firm when the arm was flexed against resistance. However, it did not become as firm as the mass on the front of the lower left upper arm. It was believed that the tendon of the long head of the biceps could be palpated when the arm was flexed and extended. The diagnosis was bilateral, independent, ancient ruptures of the biceps brachii, and it was believed that the pathology was in connection with the long head side of the muscle, with a probability that there had been damage, and possibly dislocation of the long head tendon on the left side. (Figs. 1 and 2.)

Taking into consideration the length of time that had elapsed from the injury to the first examination of patient—about eighteen months in the case of the left side, and about ten or twelve months in the case of the right side—and taking into consideration, at the same time, the very irregular outline of the mass on the left side, we had some doubt as to the advisability of undertaking an operation. It was finally decided to do an operation on the left side only, leaving the right side alone, pending subsequent developments.

An incision was made through the skin and fascia over the front part of the left upper arm, extending from a point near the supraglenoid attach-

ment of the long head to the lower part of the left upper arm just above the elbow.

The sheath of the biceps was apparently present. It was divided in a



FIG. 1. Left arm, about eighteen months after sudden development of swelling.



FIG. 2. Same patient, right arm, ten or twelve months after swelling was first noticed. Enlargement was gradual.

vertical direction, and the structures explored. There did not appear to be a detachment of the long head of the biceps, but the muscular fibers had been stripped from the tendon and rolled up into an irregular mass in the front part of the lower left upper arm. The mass was fixed by the development of new tissue, like that usually following a trauma. It was observed that the tendon appeared to be smaller and smaller as the exploration was carried downward from its point of upper attachment. The tendon was relaxed and appeared to lie loosely above the irregular musculofibrous mass.

It was apparent that there was not a reasonable possibility of disentangling the irregular muscular mass in the lower part of the biceps region. Another observation that was of considerable interest was that the tendon of the short head was much heavier than usual, and appeared to be largely muscular in character. It was believed that the short head side of the biceps was attempting to take over the function of the practically destroyed long head side.

Since there was no dislocation of the tendon that would appear to make it wise to undertake a radical transplantation of it, and since it appeared to be impossible to disentangle the irregular mass fixed by traumatic reaction in the lower left biceps region, it was decided to shorten the long head tendon as much as possible, and to suture it to the short head tendon, at the same time placing sutures in the distorted musculofibrous mass in such a way that there would be a lifting-up effect when the sutures were tied.

There was no particular postoperative difficulty, and the patient was temporarily discharged a week after the operation. He was seen several times after that, and was kind enough to say that he thought that the arm upon which operation had been done was stronger and more comfortable. The patient left our service after a few weeks. In the meantime, we had not done anything at all in connection with the mass in the right lower biceps region.

As we have indicated, we are quite strongly of the opinion that in the case of this particular individual, and individuals like him, with perfectly normal muscular development and good health, there is a predisposition to rupture of the muscles due to strain and overwork. In other words, this man, 5 feet 2½ inches tall and only 137 pounds in weight, was trying to do the work of a strong man, but he did not have the physique necessary for such work. With such a conception of the situation, we are distinctly of the opinion that substandard physique, regardless of how normal the patient may be in ordinary respects, is a definite predisposing cause.

The patient whose case we have just reported came to us in 1934. In looking over the literature we were fortunate enough to find a most remarkable and instructive article by Edgar L. Gilcreest, of San Francisco, published in the *Journal of the American Medical Association* in 1925. He had done the "ground work" for us, and it was only necessary for us to sit down, read the article, look at the drawings and make a diagnosis.

We learned from that article that Petit is credited with the first report of a case of rupture of a muscle in 1722.² Then for nearly 150 years nobody seemed to be interested in the subject.

In the United States, W. W. Keene gave some impetus to the study in a report of seventy-two cases (presumably of the biceps), published in the *Annals of Surgery*, May, 1905.¹

After another apparent lack of interest, occasional contributions appeared in European publications about twenty years later, and about that time Gilcreest and his associates entered the arena. Their contributions have been voluminous and constructive. Their articles have appeared in practically all the important surgical publications of the country, and in connection with them there are unmistakable evidences of industry, tenacity of purpose, erudition and fairness. In his earlier articles, and since then, he has mentioned A. W. Meyer, Palo Alto, California, and many others who with him are interested in this entrancing subject. A most extensive and exhaustive article, entitled "Unusual Lesions of Muscles and Tendons of the Shoulder

Girdle and Upper Arm" by Edgar Lorrington Gilcreest and Piero Albi, San Francisco, was published in *Surgery, Gynecology and Obstetrics*, May, 1939. It contains a tremendous fund of information, and both Dr. Gilcreest and his associate, Dr. Albi, are to be most heartily congratulated.

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PATHOLOGICAL CHANGES INDUCED IN TENDONS THROUGH TRAUMA AND THEIR ACCOMPANYING CLINICAL PHENOMENA*

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THE function of a tendon is a purely passive one of transmission of tensile stress produced by the motor action of muscle. This function, at the same time, demands a gliding of the tendon either on or within the surrounding tissues, or within its synovial sheath. We know of no single metabolic function whose activity is dependent on or concerns the tendon itself, and conversely, no disturbed metabolic processes are known to produce alterations in tendons, except amyloid disease, ochronosis or hypercholesterinemia.

In order to appreciate pathologic alterations of tendons, we must have a clear concept of their normal histology. A tendon is composed of parallel fibers of collagen held in compact bundles partly by an encircling epitenoneum. Since Ranvier¹ we have talked of tendon corpuscles as tendon cells, and numerous authors have investigated the part played by these corpuscles in the growth or regeneration of tendon.^{2,3} The results of these investigations are contradictory and all assume that tendon cells are particular and specialized cells related only to tendon.

Histologic and pathologic investigations (carried on in the Surgical Laboratory of the Stanford University Medical School) reveal some interesting facts bearing on this question. If one studies fresh tendon tissue of the mouse, in which the extensor tendons of the toes can be examined in their entirety from muscle-tendon junction to their attachments, the tendon cells lie apposed in parallel rows, with oval nuclei when seen in full face, much as a beaded string, seen in profile. These "tendon cells" lie between the closely packed parallel collagen fibrils, and on close examination can be seen to enclose or line tiny canaliculi or longitudinal spaces. In certain preparations, I have sometimes been able to demonstrate their direct lateral connections with blood vessels traversing the tendon in an oblique or transverse direction deep within the tendon. The

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FIG. 1. Glycerine mounted mouse tendon—Delafield's hemotoxylin stain. The photograph to the left near the upper border of the tendon shows profile appearance of the tendon spaces with the nuclei bead-like in arrangement, and the opposite fine border of the lumen. In the microscopic photograph on the right, the full face of the cells are apparent. The continuity of the structure from cell to cell can be observed.



FIG. 2. Photomicrograph $\times 900$. Fresh mouse tendon—supravitaly stained with neutral red. The collagen fibers do not take the stain. The cells of the tendon spaces show fine granules of the vital dye distributed throughout their cytoplasm as shown by the stippled or dotted areas in the tendon. Cell and nuclear outlines are not shown above. With the light stopped well down, through the microscope, the relation of cell and nucleus to the granules is easily made out.

same structures can be seen in paraffine sections of dog or human tendon stained with borax carmine. Figure 1, a glycerine mounted mouse tendon stained with Delafield's hemotoxylin, illustrates these characteristics.



FIG. 3. Photomicrograph of human tendon (sublimus tendon of index finger). Paraffin embedded section. Hematoxylin and eosin stain $\times 600$. The central part shows a portion of a tendon space.



FIG. 4. Photomicrograph of dog tendon $\times 600$. Hematoxylin and eosin stain. The tendon had been divided two weeks previously. This particular photograph was taken from the tendon proximal to the tendon end which was covered with a cap of granulation tissue springing from the epitenon. The central tendon space of the photograph is enlarged and contains red blood cells.

When one uses fresh tissue and the supravital dye technic of Warren and Margaret Lewis,⁴ one finds that these tendon cells take the neutral red dye in the same manner and with the distribution of granules that Warren Lewis showed to be characteristic of endothelial cells. (Fig. 2.) By this technic and by comparison with known tissue cells, one can demonstrate that these cells are not fibroblasts, cartilage cells or macrophages. In addition, one can refute the view held by some investigators in the past, that they are nuclei of a continuation of the muscle sarcolemmal sheath. Their reaction to vital dyes, their arrangement in continuous rows and the fact that they line spaces, suggest that they are endothelial in nature. That they are continuous with the endothelium of blood vessels in normal tendon, and that they may open up into blood sinuses of granulation tissue in severed or injured tendon, can be seen in carefully prepared specimens. (Figs. 3 and 4.)

The tissue culture work of Margaret Lewis⁵ has shown that collagen fibrils are laid down by the activity of living fibroblastic cells, but since the fibrils themselves become extra cellular, they do



FIG. 5. Rat tendon—fresh glycerine mount $\times 900$. Granules of Prussian blue shown in the tendon space deep within the tendon.

not necessarily maintain contact with their parent cells, and in a sense, lose their living properties. In vitally stained tendons, fibroblasts are conspicuously lacking except in the outer ensheathing fibroelastic layer of epitenon. We can regard tendons then as composed of compact parallel bundles of inert collagen fibrils, encircled by fibro-elastic tissue and traversed longitudinally by extremely fine capillary spaces, which probably under normal circumstances contain plasma but no cellular elements of the blood.

Additional evidence for this concept is furnished by the following experiment: One-half cc. of a 50 per cent solution of iron and ammonium citrate was injected into the tail vein of a white rat. After an interval of twenty minutes, extensor front paw tendons were removed from the anesthetized animal and placed for ten to fifteen minutes in a 2 per cent solution of potassium ferrocyanate. A single small tendon was then placed under a cover slip in acidified glycerine (1 per cent hydrochloric acid). The Prussian-blue reaction of iron could be found in the tendon spaces. (Fig. 5.) With formalin fixed paraffin sections counterstained with borax carmine, it was possible to show the Prussian-blue reaction in the spaces of the tendon of such injected animals. The lining cells of the spaces were found to undergo a blue staining with brilliant azure granules within

the nuclei. These preparations were obtained with difficulty because of the solubility of iron ammonium citrate in aqueous fixatives, while alcohol fixation precipitated abundant long needle like crystals in the tendon disrupting its structure. (The crystals failed to stain with Prussian-blue.) It should be noted that following injection, the iron could be identified only in the kidney, liver, spleen, tendon, lung, and on one occasion in the capillaries of the perirenal fat. Cartilage, muscle and bone showed no similar reaction. It is hoped that further studies of this problem may subsequently be reported in detail.

German investigators⁶ showed not only the inextensibility and lack of distensibility of tendon, but also found that tendon or fascia on dehydration loses no length, but diminishes in width or diameter, and on accurate weighing, loses little moisture. Moisture is necessary for the pliability of the tendon fibers, which otherwise become like dry rawhide. One might assume that the fine channels of the single-layered, endothelial cells in the interstices of the tendon bathe the collagen fibrils with plasma, thereby maintaining their pliability and having an internal lubricating effect, rather than conveying nourishment and removing metabolic products.

The microscopic blood circulation of living tendons in the rat was studied by means of brilliant carbon arc illumination of the exposed paw extensor tendons in the anesthetized animal (nembutal intraperitoneally). Mineral oil covered the exposed area, increased the clarity of microscopic picture and served to delay thrombosis of the vessels. With such preparations, by reflected light rather than by transillumination, each tendon was seen to be accompanied by arterial and venous vessels. These in turn send S-shaped loops across or beneath the tendon, and capillary penetration of these fine tendons was clearly shown. The capillary flow was seen to be rapid, intermittent, and reversible in direction. Section of the sciatic nerve did not open up the tendon spaces to a capillary flow of red blood cells.

With such a conception in mind, we might more easily explain the pathological changes that are found in tendon injuries or disease. First, that major injury of tendons is necessary to produce pathological changes, a sort of "all or none effect." No one has been able to show that normal replacement of tendon collagen fibrils takes place during adult life in a way similar to the constantly occurring growth and shedding of epithelial cells of the skin and mucous surfaces.

Severed tendons heal and unite, when sutured, by granulation tissue with scar formation. Under the influence of tissue tension and tensile stress, the collagen fibers of such granulation scar tissues

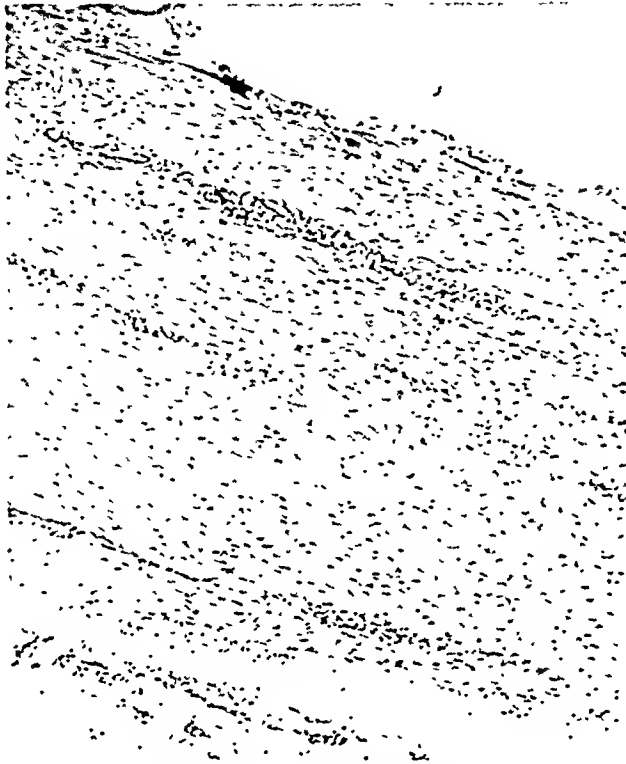


FIG. 6. Photomicrograph—Hematoxylin and eosin $\times 100$. Longitudinal section of tendon callus. The nuclei tend to orient their long axis parallel to the direction of the tensile stress.

tend to become arranged into parallel bundles scarcely distinguishable from normal tendon and function admirably, but the tendon cells do not consolidate the tendon callous.

Tendon rupture in sheathless tendons may be followed by spontaneous repair with lengthening of tendon and loss of mechanical efficiency. This spontaneous repair at a distance differs in no way from the repair following suture. (Figs. 6 and 7.) Such repair is by granulation tissue from the surrounding vascular paratenon structures. The tendon cells, as a specific type of cell, do not reform the tendon, but the developing scar tissue under tissue stress lines up the developing collagen fibrils into parallel bundles.

CASE 1. J. F. S., age 40, a traveling salesman, was injured in an automobile accident January 7, 1940. He suffered a cerebral concussion, frac-

tured ribs, 6th, 7th and 8th, right, and contusion of dorsum of right hand with several small glass cuts on same hand. Convalescence was short and without evident complication. During the first three weeks all movements

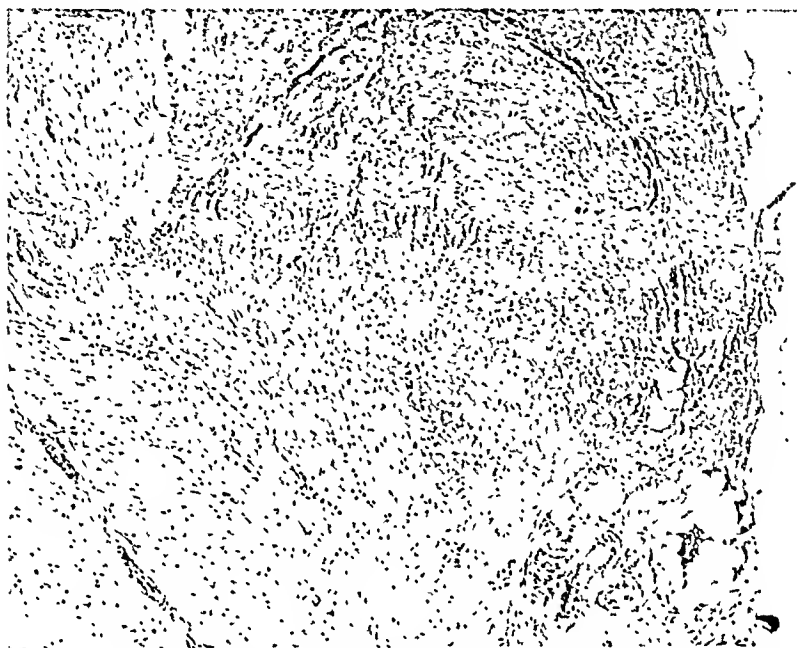


FIG. 7. Cross section photomicrograph of the same tendon callus. The tendon-like structure is well illustrated in the two photographs. The blood vessels seem to divide the callus into poorly formed bundles of fibers.

of the fingers of the right hand were perfectly normal. An x-ray of the hand and wrist revealed no fracture. After three weeks, a small, subcutaneous nodule became apparent over the dorsum of the index finger knuckle in the neighborhood of one of the healed glass cuts. A week later, a similar lozenge-shaped, subcutaneous nodule appeared near the wrist, overlying the index metacarpal. Both nodules moved with finger motion, and as time passed they became more prominent and began to be painful. A "drawing sensation" was complained of, and flexion of the finger increased the feeling of strain which gradually became more annoying to the patient.

On March 7, 1940, operation was performed under local anesthesia. The lozenge-shaped nodule was found to be the proximal end of the severed extensor digitorum communis tendon of the index finger. The distal end was found overlying the metacarpal phalangeal joint on the radial aspect of the knuckle. The intervening tissue between the two tendon ends consisted of grey, pearly, opaque tissue of dense, tough consistency without visible fibers, and which surrounded the proximal tendon end like a glove. This tissue was continuous to the distal tendon stump, a distance of 7 cm., and also ran over to the tendinous vincula and mesotendon of the common extensor tendon of the midfinger, while towards the radial side of the hand it became thin and filmy. The tissue was readily peeled from the tendon

stump by sharp dissection. The entire "tendon callous" was excised in one mass. No other evidence of proliferation from the severed tendon ends could be made out. The tendon stumps were sutured accurately with black silk, the subcutaneous tissue and skin approximated with similar sutures. The hand and wrist were placed in slight dorsiflexion of the wrist, with moderate flexion of the midphalangeal joint, and with not quite complete extension of the metacarpal phalangeal joints.

The splint was removed in three weeks. Return of finger and wrist motion quickly followed, and the patient was discharged on April 26, 1940, with complete restoration of function without pain or tenderness.

The typical tendon callous, whether after suture or following separation of tendon ends and repair at a distance, as in this case, does not grossly resemble tendon tissue, but under the microscope paraffin embedded stained sections bear a striking resemblance to tendon structure. (Figs. 6 and 7.)

Secondly, when injury to tendon occurs, short of severance or rupture, it is the fibrovascular epitenon, the vascular mesotenon, the paratenon or vincula, bearing blood vessels, which respond with pathological changes, rather than the tendon collagen fibrils themselves.

Traumatic stenosing tendovaginitis of De Quervain may follow a single blunt injury, as in the following instances:

CASE II. L. M., age 29, a male house boy, while scrubbing the kitchen on February 9, 1940, with a circular motion of the right arm he struck the radial side of the right wrist against a corner of the kitchen table leg. The wrist continued to be sore and tender, and the patient experienced difficulty lifting with this hand. Examination on February 12, 1940, showed swelling of the radial side of the wrist with obliteration of the anatomical snuffbox of the thumb. The tip of the radial styloid was exceedingly tender on pressure. The patient had pain in this area on abduction of the thumb against resistance, and on passive hyperadduction and flexion of the thumb with the thumb held in this position by closing the fingers, ulnar adduction of the wrist was excruciatingly painful. Physical examination revealed no other abnormalities, and there was no evidence of urethritis. The patient had no fever and the white blood count and differential count were normal. The sedimentation time was rapid. The patient was fitted with a moulded leather, re-enforced splint, holding the thumb in abduction and preventing motions of wrist and thumb. The patient, being relieved of all distress, continued to work.

The splint was discarded on March 26, 1940, but by April 2, 1940, the pain and tenderness recurred. By April 4, 1940, "snapping thumb" of the distal joint appeared. Operation for traumatic stenosing tendovaginitis was carried out on April 6, 1940, under local anesthesia.

The tendon sheath of the extensor brevis and the abductor longus were first exposed and incised. A probe was readily entered into the tendon sheath without finding stenosis. On incising the sheath, one found there was definite thickening which was apparently extension of the dorsal carpal ligament, but on the outer surface it had a grey, brownish yellow appearance, as if old blood pigment were in the tissues. On opening the sheath completely, one found the inner surface of the tendon sheath moderately injected, and the mesotendons of both tendons were definitely engorged. The tendons ran through what appeared to be a bony groove with high, sharp walls. This felt perfectly bony hard to touch, but after the tendon sheath and its ligamentous thickening was dissected further, this apparent bony wall was found to be indurated tissue and attached to the periosteum. This was excised for section. The tendon sheath of the extensor pollicis longus was then exposed and the tendon was found held tightly gripped by a markedly thickened dorsal surface of the tendon sheath, and one could not place a probe from the lower free portion of the sheath beyond this obstruction. In addition, on voluntary or passive movements of the terminal phalanx of the thumb, one found there was a trigger tendon present, and before fully opening the sheath, on movement of the terminal joint, one saw a "jumping catch" of the tendon beneath the tight scarred band and a rotary twisting of the tendon as well. On fully opening the sheath, one cut through a gristle-like tissue on the anterior border, and exposed the synovial surface of the sheath which was more than moderately injected. The tendon showed signs of inflammation and on its anterior surface, at the distal anterolateral portion of the mesotendon, was a small protuberance, brown, reddish-grey in color, $1\frac{1}{2}$ to 2 mm. in diameter, which felt perfectly hard. This was carefully dissected from the tendon. The underlying tendon looked seared and brownish, but there was no apparent gross defect in its fibers. It was now noticed that the tendon moved in full range of motion without any rotary or twisting torsion. An apparent bony groove was again found about this tendon, and as before, on lifting up and dissecting forward the sheath itself exposed the underlying tissue as dense, hard and gristle-like. This was excised. The anterior portion of both tendon sheaths were completely excised, the subcutaneous tissue and skin closed with interrupted sutures of fine silk after suturing the deep fascial structures over the tendons. The wound was dressed with tincture of benzoin gauze and sterile gauze dressings. Cultures of the synovial fluid were negative.

The patient returned to work on April 18, 1940, and has remained symptom free. He was last observed on May 2, 1940.

The edematous and vascular synovial lining of the tendon sheath is shown in Figure 8. The walls of the bony-hard gutter through which the tendons coursed, are shown in Figure 9. Instead of bone or cartilage, it is a compound of fibrous tissue bundles separated by

edema and containing numerous, large vascular sinusoids. The hard nodule on the surface of the tendon, and which was responsible for the development of the trigger thumb proved to be organizing granulation tissue.



FIG. 8. Photomicrograph $\times 100$. Hematoxylin and eosin. This synovial lining shows the edema and vascularity of the typical case of stenosing tenosynovitis.



FIG. 9. Photomicrograph $\times 100$. Van Gieson's stain. Considering the marked vascularity of the edematous fibrous tissue, (2 months after injury) it is difficult to reconcile such an appearance with the bony-like consistency found at operation.

CASE III. L. L. The last week of March, 1939, the patient, age 40, a shop girl, struck the inner aspect of the right ankle against the sharp corner of a box. The stocking was torn, and the ankle, at the site of contusion, became black and blue. The patient treated the lesion herself with hot compresses but no improvement was evident. The initial swelling subsided to be followed later by localized swelling, tenderness and pain on weight-bearing. Examination on April 4, 1939, revealed definite localized edema beneath and posterior to the internal malleolus of the right ankle. There was marked tenderness in this area. Eversion of the ankle and inversion against resistance, as well as forced dorsiflexion, produced pain. (Strapping of the ankle gave only partial relief.) X-rays of the ankle showed the bony structure to be normal. On April 28, 1939, the area was injected with novocain; the posterior tibial tendon sheath was injected with air. Radiographs showed the tendon sheath well outlined and apparently narrowed beneath the malleolus.

Operation, May 12, 1939, for traumatic tenosynovitis and stenosis of the posterior tibial tendon sheath was performed under local anesthesia. On exposure of the sheath, a tense bulging area with thin walls was found distal to the dense fibrous retinaculum beneath the malleolus. Pressure on the bulging sheath reproduced the patient's previous pain. On incising this area of the sheath, brownish, straw-colored, clear mucinous fluid was evacuated. (Cultures of the fluid were negative.) The tendon in this area

was bulbous and fusiform over a distance of 3 cm. The sheath was incised proximalward for 6 cm. and found to be engorged, with a velvety red appearance, the mesotenon markedly swollen with pannus-like projections



FIG. 10. Photomicrograph $\times 100$. Hemotoxylin and eosin. The marked vascularity of the synovial layer gives rise to a velvety, deep red appearance in life. The fibrous character of the outer layer of the sheath is here more marked than is usually encountered.



FIG. 11. Photomicrograph $\times 100$. Hemotoxylin and eosin. Such villi, brilliant deep red in gross appearance, are found to be extremely vascular with an interstitial edema. The perivascular round cell accumulation near the base is an infrequent finding.

on the under surface of the tendon, and fine villi were found both on the inner surface of the sheath and projecting from the mesotenon.

The bulbous area of the tendon was dense-white without the mother of pearl sheen of normal tendon surface. An elliptical longitudinal section of this area was excised and the defect closed with fine silk sutures which restored the normal diameter of the tendon.

A narrow strip of tendon sheath was excised and the larger villi removed. The lower half of the sheath was retracted and the sheath incised through its length on the inner, deeper surface down to the loose areolar layer. This allowed the sheath to be closed without constriction and with the preservation of a tendon retinaculum.

The patient returned to her work on June 14, 1939, and has continued without recurrence of difficulty.

Figure 10 illustrates the thick-walled, fibrous sheath of the stenosed area with an edematous and vascular synovial lining. A characteristic villous synovial granulation is shown in Figure 11. These richly vascular, edematous villi arise from the synovial sheath or the mesotenon. The late reaction of the tendon itself to the trauma is shown in Figure 12. Here one sees numerous vascular sinusoids of an edematous granulation tissue lying between and invading the parallel collagen bundles of the tendon proper.

While the vascular tissues of the fibro-osseous canal may in many instances show the greatest tissue changes, the tendon through its sheath or epitenon, or by vascular changes within the center of the tendon itself, in these instances demonstrate the result of injury.



FIG. 12. Photomicrograph $\times 100$. Hemotoxylin and eosin. Deep within the bulbous tendon of changed gross appearance, this area was found seven weeks following injury; edematous granulation tissue having large vascular sinuoids spread apart and distort the tendon bundles.

"Tenosynovitis fungosa" may follow repeated blunt trauma. In this condition which occurs in sheath tendons (in each instance which I have encountered the extensor tendons of the fingers beneath and at the distal edge of the dorsal carpal ligament were the site of this disease) the granulation tissue apparently develops in mesotenon or the vincula and by virtue of constant irritation through repeated frequent motion, the granulations continue to develop. The vascular granulations invade between the tendon fibrils, and by vascular erosion lead to fraying of the tendon under tensile stress and to eventual rupture. Whether the spontaneous rupture of the long head of the biceps falls in this class of change, I have not had the opportunity of ascertaining. Mechanical attrition with fraying of tendon, such as occurs in the supraspinatus and other tendons and pointed out long ago by Mayer⁸ may go on for months or years until acute symptoms manifest themselves in an attack of "acute subdeltoid bursitis."⁷

In essential ideopathic hyperchlosterinemia deposits of unsaturated fats and sterols may accumulate in para and mesotenon about the small capillaries producing xanthomatous tendon tumors. While this process is a disturbance of general lipid metabolism, it is

in the vascular bed of the tendon extension apparatus that the lipoid deposit takes place. The tendons are involved secondarily by adhesions and vascular erosion from the lipoid granulomatosis. Location of such xanthomas may possibly be initiated by trauma.²

CONCLUSION

Tendons possess an internal endothelial lubricating apparatus maintaining the pliability and suppleness of the moving part. The collagen fibrils may be considered as inert, extra cellular material. They do not participate in metabolic processes, and are incapable of response to irritation or trauma, except that of mechanical fraying or rupture.

Trauma to the tendon-traction apparatus must involve the vascular structures to make a response towards healing possible. The attempt at healing may produce clinico-pathological phenomena arising from interference with free unimpeded tendon motion, or from vascular erosion of tendon fibers. In this manner, a single or repeated tendon injury may call forth diseased states which may become chronic, and at first glance, seem unrelated to the initial injury.

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DISCUSSION OF PAPERS OF DR. DOBBIE AND DR. HOWARD

HENRY C. MARBLE (Boston, Mass.): The hour is late and the body is weak, so I will make my discussion brief. I hoped that I might not say anything, but I cannot again let efforts at "post-hope" reasoning go unchallenged.

May I call your attention to just two facts: The most commonly injured part of the human body is the hand, probably ten times as often as any

other single part of the body. I repeat: The human hand is probably injured ten times as often as any other part of the body.

In the registry of bone sarcoma maintained by the American College of Surgeons, osteogenic sarcoma of the hand is authentically reported in one case, and that is my case, and the patient did have it. I am sorry that that is true because then my story would be 100 per cent, but if we think of the tremendous number of traumas that occur to the hand, and we think of the registry of bone sarcoma, there is only one authentic osteogenic sarcoma of the hand reported, and it reduces it to a very small possibility of trauma.

Next, I recently looked up the cases of fractures which we have known and reported as trauma, not minimal traumas like slaps on the wrist and kicks in the shin, but real trauma, and in the Massachusetts General Hospital's series of fractures, we have not a single malignancy following an injury except one. We had one case of Paget's disease which subsequently had a fracture and subsequently had a sarcoma. So let us reason the matter of the relationship of malignancy to trauma, from trauma to malignancy, and not from malignancy to trauma, and then maybe we will have better results.

Now, the next matter that I have to discuss is the matter of the preservation of tendon function, and I just thought as I listened to that excellent paper, that, after all, genius is only the capacity for infinite pains. In the matter of constructing a hand as he showed in the pictures, I have only admiration.

I would go him one further and say that at one time I had a man who had a complete amputation of all four fingers and the thumb at the metacarpal phalangeal joints and as a result of about a year of struggle, and as the result of several surgical operations, I digitalized the metacarpal bone of the thumb to such an extent that the patient could hold a pencil between the thumb and the index metacarpal bone, and the patient is now earning a living. He can write; he can feed himself; and that little amount of motion which he has between his thumb and index finger, he believes justifies several anesthetics and an awful lot of hospitalization.

I believe that notoriously artificial hands are inadequate and unsatisfactory and any degree of function which we can have even to a centimeter between two opposing parts of the hand, is worth while and should be obtained.

That was an excellent presentation. The matter of grafts as he puts them on was beautifully demonstrated. I confess that I use a rope graft more than I do the two-ended graft flap such as he showed. I like the rope graft, and, after all, it is the weapon you like to shoot with best that kills the most fowl.

I think sometimes we can hasten matters if early in the injury we proceed to prepare the graft. I mean prepare the rope and have it ready to put on by the time that the injured part of the hand is clean and is ready to receive its graft. If we have previously prepared the rope on the side and put it on, sometimes we can save two or three valuable weeks—that is, to

synchronize our surgery—and that is a good word, is it not, “synchronize” our surgery?

The avulsion of the lower tendon of the biceps interested me because I have written letters to Dr. Dobbie on that subject. The matter of avulsion of tendons from bone is intriguing. Our results, I think, vary with our ability to diagnose them. The two cases that I have seen of rupture of the lower insertion of the biceps were both easily diagnosed. The results were good.

The other end of the biceps tendon is more difficult to diagnose and the results are not quite so good, but thereafter when we have had ruptures of the supraspinatus muscle, which are difficult of diagnosis, and the operation has been postponed, our results have been poorer.

I was glad to hear Dr. Dobbie tell about his results as to insertion of the lower end of the biceps into the soft tissues, and I think it sort of discourages me because, personally I like to dissect the antecubital space. I think it is intriguing. There are large vessels there, and Dr. Brewster used to say, “Don’t ever worry about anything you can see; it is the things you can’t see that you should worry about.” In the bend of the elbow, you can see, and the anterior approach to the elbow is interesting. We find the great vessels and can easily turn them aside, and then the supinator muscle, and in the inner wall of the great supinator we find the radial nerve and the muscular spiral, and pull it out, and below it is the insertion of the biceps; and, by supinating the arm, the bicipital tuberosity comes up to this line, and with a simple dissection we can go around the radius and a piece of fascia lata makes a good anchor. I like to do the operation, and I am sorry they do so well who do not do that operation, but I suppose it is correct.

It is a very interesting piece of work and a very useful piece of work. The cases that I had were all over fifty, middle-aged workers who returned to their usual work after operation.

Dr. Dobbie did not say (which I think is important) that if the patients are splinted in supination, I believe their power of supination will ultimately be better.

On the last presentation, read by Dr. Howard, I have little to say. I think it is a grand bit of work on the pathology and histology of tendons. To me it just pointed one lesson. Recently I have seen come from a great distance, two patients. The second patient had on the flexor surface of his fingers two large tumors, each about 2 cm. long and 2 cm. wide, and elevated maybe a centimeter and a half or a centimeter, which obstructed the function of the hand very materially—all of this following tendon suture. I thereupon explored these tendons under novocain and when we had opened the tumor, we found that it was a foreign body cyst, and having removed several large pieces of silk, and nothing more, the cysts were reduced in size and the patient proceeded to make a happy recovery.

Why we feel the need, when we repair tendons, of going and borrowing a canal-boat hawser, I cannot quite understand. The tendon, as Dr. Howard

has pointed out, is a delicate structure, and will heal if given half a chance, and by much simpler methods than we have used in the past. By approximating the ends of the tendons with very simple sutures, very gently done, we can approximate the delicate structures, as he has shown you in the lantern slide, and I think very, very satisfactory results can be obtained.

I think he is to be particularly congratulated upon the thoroughness of his work and the thoroughness of his study of the literature.

D. C. PATTERSON (Bridgeport, Conn.): Dr. Marble has so ably discussed these papers that there is very little left to be said. The papers and discussion have been most instructive and interesting.

Dr. Howard did mention one thing, though, that I should like to call to your attention, and that is the matter of DeQuervain's disease. He said, I believe, that he had seen it develop from a single trauma. We have had some little experience with this condition but I have never seen it develop from a single trauma. We have always thought that it was due to repeated traumas. To those of you who are not familiar with the condition, I would like to mention something about it because it is, to my mind, the most satisfactory disease to meet that the human body is afflicted with, because diagnosis is generally easy, and the result is practically a 100 per cent cure.

The condition was first described by DeQuervain in 1895 or 1896, as a narrowing of the tendon sheath that transmits the extensor brevis pollicis and the abductor longus pollicis, through a groove in the styloid process of the radius. If you will put your thumb in your hand and close your fingers over it and sharply ulnar adduct your hand, you will get a pain over the radial styloid which is perfectly typical of the pain these patients suffer most of the time.

Kocker gave the condition the name of stenosing tenovaginitis, but it is generally known as DeQuervain's disease. There are very few papers in the American literature on the subject, only four or five, I believe.

The pathology is a thickening of the tendon sheath with, of course, that part of the carpal ligament which goes over it. It is most frequently found in women. Out of the 145 cases that Snyder collected, mostly from foreign literature, 114 were in women and the remainder in men.

We have had more than a dozen cases of this disease. They occurred mostly in men who were working at tasks that required pressing with their thumbs, such as on a grinding machine or on a buffer. There was one woman that had been working placing a rubber ring over the end of a brass pipe. Her employers had a rush order on this piece of apparatus and she had performed that operation five hundred times in one day. That night she had severe pain in both wrists and was treated with heat and massage. Baking, strapping, etc., were carried out for about a month without any benefit whatever.

The symptoms are: pain over the radial styloid and interference with abduction of the thumb. The pain may extend up the arm or into the thumb. The tenderness is absolutely localized to a small spot right over the

radial styloid. There is no tenderness anywhere else. These patients become disabled, as they gradually lose the strength in the thumb and drop articles. That will go on until operation has been performed.

The operation and cure of the condition is so simple that I do not think conservative measures should be considered at all. There have been some cases reported of cures within four to six weeks in a plaster cast, but nothing has ever been said about recurrences in those cases. I have never seen a cure by nonoperative treatment. The operation can be done under local anesthesia, with a two-inch incision over the radial styloid and, as Dr. Howard pointed out, the annular ligament with the tendon sheath will be found tremendously thickened. We have found it at times at least a quarter of an inch thick and sometimes almost cartilaginous.

The tendon sheath is incised, which allows free passage of the tendon. The wound is sutured and a simple dressing applied. No splinting is necessary. Patients are allowed to use the thumb within a few days, and the period of disability is never over two or three weeks and, as I mentioned before, the cure is practically certain in 100 per cent of the cases.

TORR WAGNER HARMER (Boston, Mass.): I should like to present the only case of avulsion of the lower bicipital tendon which has come under my care. The story is as follows:

November 30, 1938: G. D. L., was a powerfully built stationary fireman of forty-seven, weight 190. Several hours previous, while attempting to lift the rear end of a Ford car, he felt a snap in the front of his right elbow. There was much tenderness in this area and no contraction of the biceps muscle when attempting to flex the forearm. It was believed the distal bicipital tendon had been torn off the muscle belly. Preparations were started for fascial repair.

December 1, 1938: The radial nerve was exposed above the elbow and followed into the antecubital space to its division into the posterior interosseous and radial cutaneous branches. The biceps tendon was found avulsed from its attachment to the bicipital tuberosity. The tendon was found coiled up under the distal end of the muscle belly. When straightened, it was about four inches long. The bicipital fascia had been completely torn. Retraction of the supinator longus showed that the tendon had been avulsed from the bicipital tuberosity of the radius. There was not even a fringe of tendon remaining. Reattachment was regarded as undesirable because of inaccessibility, and the possibility of limiting pronation and supination. Accordingly, the tendon was split lengthwise, each half was threaded on a large Gallie needle and woven into the attachment of the brachialis muscle, one half being introduced from the medial side and the other half from the lateral side. A thong of fascia from the left thigh was loosely whipped about the upper end of the tendon to prevent its splitting into the muscle, then loosely woven through the split biceps tendon down to the new attachment into the brachialis insertion. It was here woven into this attachment.

Primary union was secured and the patient discharged from the hospital on the tenth day. Four weeks after operation there was good flexion of the forearm from a point just beyond a right angle. Nine weeks after operation, extension of the forearm lacked twenty degrees; flexion was complete with excellent contraction of the biceps. The man returned to work as stationary fireman, stoking several fires in a large building, in twelve and a half weeks.

NELSON J. HOWARD (closing): I want to thank Dr. Marble and Dr. Patterson for their kindness and their discussion. I do not know whether I should ask Dr. Marble in public what his reference to the thoroughness with which I covered this, meant, whether it was a gentle form of sarcasm or not. I sent him a manuscript and did not include a bibliography, so I have occasion to believe I am being taken for a ride.

While certainly many instances of DeQuervain's stenosing tendovaginitis do follow repeated trauma or follow Colles' fracture, in my experience I have had definite instances in which they followed single traumatic incidents. The case which illustrates it best is that of the Filipino boy scrubbing a marble floor, and as he went along the edge of a sharp-cornered wash stand, with metal corners, he bumped his wrist into the sharp corner. He had pain, increasing disability, and came to see me only two days afterwards, and I considered it would respond well to conservative treatment. I splinted it for a matter of three weeks with no improvement, and continued the splinting for another three weeks with no improvement. Operation was carried out and not only did we find a stenosing tendovaginitis of both tendon sheaths, but also involvement of the extensor pollicis longus and the abductor pollicis longus, and during the last week, the week the splint was removed, we found he had developed a trigger thumb on extension and flexion of the distal joint of his thumb. Within the stenosed sheath of the extensor pollicis longus I found a definite mass on the surface of the tendon, apparently where the major initial injury had taken place. This was separated, leaving the tendon normal in appearance, and on microscopic examination the nodular mass, which felt definitely hard and cartilaginous, proved to be dense granulation tissue.

Now, DeQuervain's stenosing tendovaginitis may be treated conservatively, if you get it early. In some cases I have had simply a molded leather splint made for the patient, with the thumb in position of grasp, the splint on the thumb extending clear out to the tip of the thumb, and within six weeks of such splinting, wearing it day and night, the patients were all continuing at their work. None of them were industrial cases. They were then able to leave the splint off, and some of the cases have now gone as long as five years, and the latest one two years, without recurrence.

There is a cartilaginous consistency of the base of tendon sheath, grooves or tunnels, and if you remove that material, you will find it is neither cartilaginous nor bony. It is not periosteal reaction but is dense, infiltrated granulation tissue.

FRACTURES OF THE UPPER END OF THE TIBIA WITH LATERAL DISPLACEMENTS

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SEATTLE, WASHINGTON

FRACTURES of the upper end of the tibia are quite common and have been a rather difficult type of fracture to treat especially as to obtaining a good functional result. The poor functional result is due in most cases to one of two conditions and sometimes both, namely, extensive damage to the ligamentous structures in and about the joint or to an inadequate reduction of the fracture. It is frequently the case that a very adequate and satisfactory reduction has been obtained but an inadequate fixation has been applied to maintain the reduction. Then again a good reduction has been obtained and too early weight bearing has been allowed permitting a recurrence of the deformity.

Sometimes it is very difficult to determine the degree of the consistency of the callus, and then of course, a too early weight bearing results in a recurrence of the deformity and the common end result is a weak, unstable knee with a knock knee deformity. In my experience when such an end result is obtained, manipulative or even open reduction for the replacement of the displaced fragments has not given very satisfactory end results, nor does the wearing of a brace seem to be of any help.

Such type of fractures may involve the entire head, yet more frequently they involve only one-half of the bone, the outer half being injured most frequently. Such a fracture usually occurs when the patient jumps from some high place and lands upon his feet, throwing a strain upon the outer side of the knee and depressing the outer half of the bone downward. More commonly this fracture is caused by a severe blow to the outer side of the knee with the knee being driven inward, such as occurs when one is struck by the fender or bumper of an automobile.

It has been the experience of the operator in this type of fracture, that the upper end of the bone has been found to be of a very soft or spongy type and can be readily compressed. When one-half of the head is compressed, the joint space between the head and femur is uneven and the joint surface is wider, thus making an abnormal weight bearing surface.

Frequently this type of fracture is overlooked because there is no definite fracture line and the only thing noted in the x-ray is some increase in the density of the bone running obliquely from the spine of the tibia down to the outer margin of the bone.

The important thing in the treatment of this type of fracture is the replacement of the weight bearing surface to as near normal as possible and the narrowing of the joint space. In this type of fracture there usually occurs a rather marked hematoma or effusion into the joint. This should be given the first consideration, and it is our policy when the patient is first seen to apply a Thomas splint, then to apply heat or cold as the case indicates and to keep the joint at absolute rest until the effusion subsides. If it does not subside within a period of three or four days, it is necessary occasionally to aspirate. It is rather advantageous to see that the joint swelling is reduced to a minimum before resorting to any operative procedure. Most of the cases presented in this paper were operated upon from four to five days after the injury.

OPERATION

The operation as recommended consists first of the usual twenty-four hour preparation as for any of the bone cases. We prefer the use of an antiseptic such as metaphen, as we believe a little better preparation is carried out. The patient is then suspended upon the fracture table (Fig. 1), which permits accessibility to the knee for operating and also for taking of the necessary x-rays at the time of the operation. A small incision is made (Fig. 2) on the outer side of the knee just below the joint and over the depressed fragment of the tibia, the fragment being fairly well exposed. A long drill which has two holes perforated in the distal end is then inserted into the fragment and the latter is elevated as much as possible, or to a point which the operator believes it should be. The drill is then passed on through the inner fragment, in a direction that when compression is applied it will be made so that the fragment is elevated and laterally approximated. When the drill has passed through the inner margin of the tibia, a second small opening is made in the skin just large enough to permit insertion of a metal button. Wire, size .039, is threaded through the holes in the drill. On this wire is threaded a button, the two loose ends of the wire are inserted into the drill holes and the wire is pulled back through the tibia. The excess wire is then removed and the second button is threaded onto the wire.

To the wire is attached an instrument that will permit tightening and the making of pressure against both buttons in order to firmly approximate the displaced fragments and hold them in position.

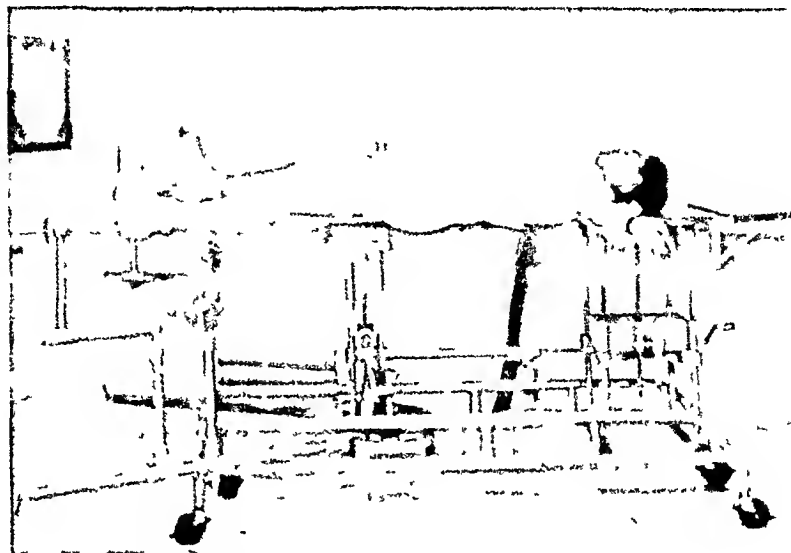


FIG. 1. Patient suspended on the fracture table.

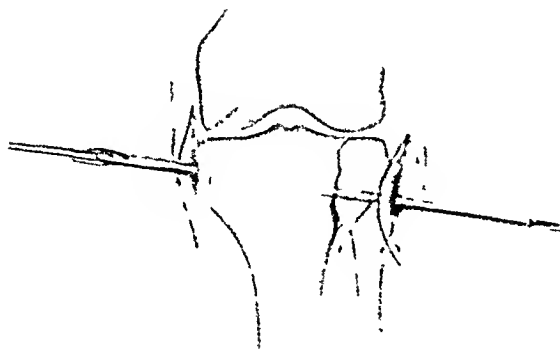


FIG. 2. Passing of drill through upper end of the tibia in the direction which would best replace the depressed fracture.

With the wire tightened as much as one thinks necessary (Fig. 3), the instrument is bent downward to permit application of a redresser (Fig. 4) in order that more lateral approximation may be obtained. With the redresser in place the wire is again tightened to take up the slack. The redresser is then removed and the leg wrapped in sterile linen and an x-ray is taken, first to determine that the wire

has been put through in the proper direction, and second, that the fragment has been restored to as near its normal position as possible.

After a review of the x-ray shows that both mentioned conditions

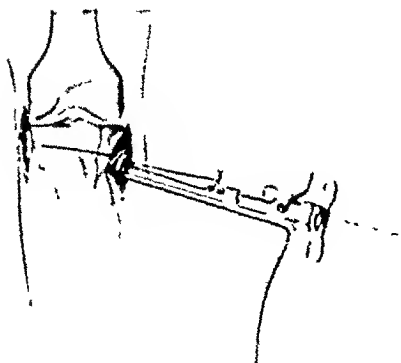


FIG. 3. Tightening of the wire by means of a special instrument which will also permit twisting and fixing buttons in place.

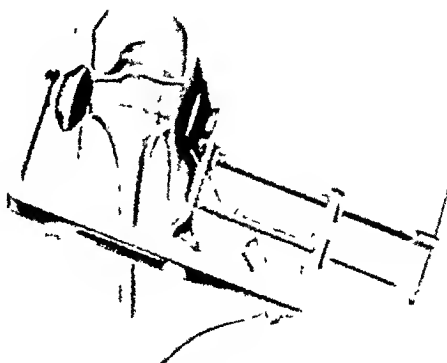


FIG. 4. Wire in place with redresser applied to make more adequate reduction.



FIG. 5. Thomas ring ambulatory ischial bearing splint.

are satisfactory, the wire is twisted. This is accomplished by fixing the set-screw on the handle, then releasing the support holding the



FIG. 6. Case I. H. S. Automobile accident. Fracture of the outer half of the head of the tibia.



FIG. 7. Case II. V. M. Automobile accident. Depressed fracture of the mesial two-thirds of the tibia.



FIG. 8. Case III. C. C. Result of jumping off a high porch. Longitudinal fracture of the upper third of the tibia with lateral displacement.



FIG. 9. Case IV. M. K. Automobile accident. Fracture of the outer half of the head of the tibia.



FIG. 10. Case v. H. V. Result of being struck by a log on the outer side of the knee. Fracture of the outer half of the head of the tibia.



FIG. 11. Case vi. E. E. Struck by an automobile. Fracture of the outer half of the head of the tibia.



FIG. 12. Case vii. G. S. Result of falling down stairs. Fracture of the outer half of the head of the tibia.

rod, as shown in Figure 3, to permit twisting of the wire. With this instrument the wire can be tightened with the threads remaining parallel and not twisted between the buttons, the entire twisting



FIG. 13. Case VIII. H. E. K. Struck by an automobile. Fracture of the inner half of the head of the tibia.



FIG. 14. Case IX. T. F. Struck by an automobile. Fracture of the outer half of the head of the tibia.



FIG. 15. Case X. E. E. Struck by an automobile. Fracture of the outer half of the head of the tibia.



FIG. 16. Case XI. E. K. Result of being struck by an automobile. Fracture of the outer half of the head of the tibia with marked depression of the external condyle of the humerus.

being made on the outside of the buttons. The excess is then removed and folded into the soft tissue.

The wounds are closed in due form and a plaster-molded splint is applied, using felt only as a pad. The anterior and posterior portion of the knee are left exposed to allow for any swelling that may take place.

AFTER CARE

The after care in these cases is usually simple. The patient is given sedatives as necessary and the cast is left on for a period of



FIG. 17. Case xii. H. F. Struck by an automobile. Fracture of the outer half of the head of the tibia.



FIG. 18. Case xiii. B. J. Automobile accident. Inverted T fracture into the joint with lateral displacement.



FIG. 19. Case xiv. A. C. Struck by an automobile. Fracture of the outer half of the head of the tibia.

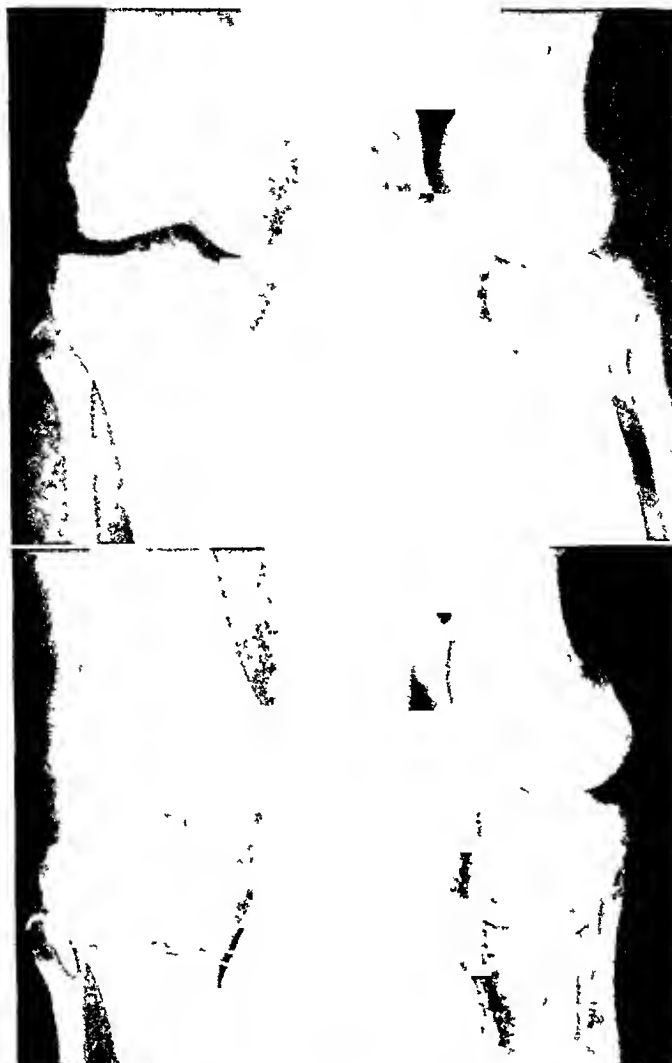


FIG. 20. Case xv. S. J. Result of falling off a trestle. Fracture of the outer half of the head of the tibia.



FIG. 21. Case xvi. P. N. Result of being struck by a log on the outer side of the knee. Fracture of the outer half of the head of the tibia.

FIG. 22. Case xvii. C. L. Struck by an automobile. Fracture of the outer half of the tibia.

eighteen to twenty-one days. We have not found it necessary to remove the sutures until that period of time, but should the patient run some undue temperature the wound is inspected before that date.



FIG. 23. Case XVIII. J. D. Automobile accident. Old fracture of the outer half of the head of the tibia.

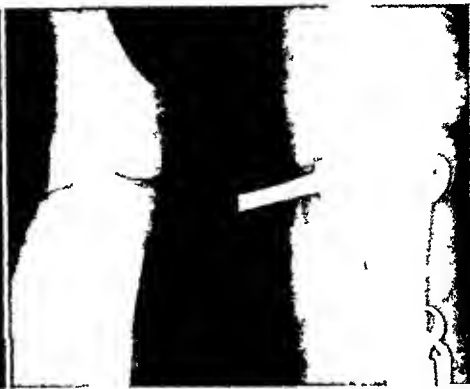


FIG. 24. Case XIX. C. S. Struck by an automobile. Fracture of the outer half of the tibia with fracture of the fibula.



FIG. 25. Case XX. T. D. McN. Automobile accident. Comminuted fracture of the outer half of the tibia.

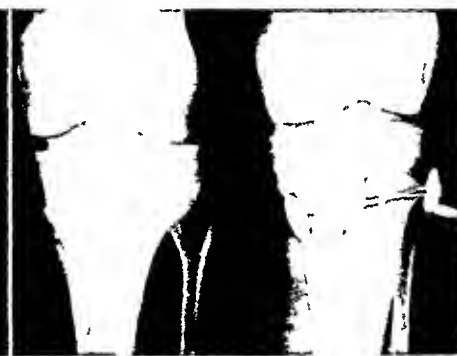


FIG. 26. Case XXI. C. B. Struck by a jitney. Fracture of the outer half of the tibia.

When there is no occasion, we do not remove the stitches until eighteen to twenty-one days, when the plaster splints are removed and the patient is then fitted with a Thomas ring ambulatory ischial bearing splint (Fig. 5), with locks at the knee joint and a strap surrounding the knee pulling it to the outer side. With this type of splint the patient can walk and carry practically the whole weight upon the ischium and permit some weight bearing on the inner side of the joint, and with it flexion of the knee joint is permitted immediately. The wearing of this splint is necessary until such time as the fracture is firmly united. It is our practice to remove the splint daily for physiotherapy to prevent muscle atrophy and to recover

function of the joint. It is seldom necessary to remove the buttons, but occasionally some of the patients experience slight irritation, particularly on the outer side of the knee and in three of the cases presented, the buttons have been removed. Ordinarily, however, there are very few complaints and the buttons are left in permanently. We have never experienced a refracture because of the remaining wire.

The most frequent complication is arthritis. This is usually caused by the direct trauma to the joint itself. Frequently people have considerable arthritic change in the joint at the time of the accident. It is our practice to treat the patient immediately for the arthritis, and it is our policy also to clear up all foci of infection; and if the patient is found to have some definite focus, we usually give him vaccines or some of the salicylate preparations. We have found that the period of time loss has been cut down a great deal by the early treatment or the prevention of this condition.

CONCLUSIONS

It has been our experience that:

1. An adequate diagnosis should be made, particularly to determine the degree of deformity caused by the fracture.
2. As near an anatomical reduction as possible should be made in order to prevent an abnormal weight bearing surface.
3. Early reduction is rather essential.
4. Early motion both active and passive, is very important to recover function of the joint, mainly to prevent adhesions forming in the joint.
5. An active arthritis should be prevented as much as possible.

DISCUSSION

HUBLEY R. OWEN (Philadelphia) showed lantern slides of nine cases of fracture of the upper end of the tibia involving the knee joint. All of these fractures were "bumper fractures." Dr. Owen stated that he had never employed Dr. Buchner's technic for treating fractures of the upper end of the tibia involving the knee joint.

In the nine cases discussed, all were treated with skeletal traction and the Braun-Baylor splint followed by a fixation with plaster of Paris encasement.

In cases of malalignment of the articulus surface of the fracture head of the tibia, Dr. Owen stated that he usually had employed fixation of the fragment with nail or screw, but thought that the method of Dr. Buckner was far more feasible than the use of nail or screw.

Dr. Owen emphasized that he thought it was of great importance not to allow weight-bearing for at least ten to twelve weeks following such a fracture of the head of the tibia involving the knee joint, that is, an inter-articular fracture. It is his practice to employ a brace in all fractures of the head of the tibia involving the knee joint, and in all cases of fracture of both bones of the lower leg. The type of brace includes a long cuff between the knee and the hip and another cuff around the lower leg. If weight-bearing without such brace is allowed in the interarticular fractures of the head of the tibia, the fragment is likely to become displaced and cause a permanent deformity of the knee joint, exactly similar to the danger of allowing weight-bearing with bi-malleolar fracture of the ankle joint too early.

In closing, Dr. Owen emphasized that he thought the method of Dr. Buckner was a great addition in the treatment of fractures of the head of the tibia. He thought that it also might be applicable in T-fractures of the condylar of the femur in being able to secure more accurate approximation of the fragments.

KELLOGG SPEED (Chicago, Ill.): I merely rise to ask a question. Seeing that these injuries occur not only in the Far West but also to the police of Philadelphia, who make their slips in spite of General Smedley Butler, I wonder if they ever have complications involving the semilunar cartilage, and I should like to ask Dr. Buckner when and how often it occurs in his series of cases, how he makes a diagnosis, and whether his treatment is affected by finding that the cartilage has been disrupted or torn?

CHARLES S. VENABLE (San Antonio, Tex.): I have been very much interested in this very ingenious method that Dr. Buckner has in pulling these fragments together. I think that it is a question of mechanics, and our carpenter friends taught us a long time ago the difference between a steel screw and a wood screw. A wood screw is made with a smooth shank joining the edges to the head and it will pull two pieces of wood, or bone, or what-have-you, together.

If you just use a screw that has threads all the way to the head, it will be sure to push those two fragments apart. I have one slide of this type I would like to show, to illustrate just what I mean.

This is one of these fractures we are talking about and I concur very particularly that these cases should be put in very early motion and function and with no weight-bearing. I prefer the suspension balance rather than plaster.

The base of this screw is the wood-screw tip, and the tighter you screw it, the closer it will pull the fragments together; and I think you can pull fragments together tighter with a screw than by wires or a bolt on one end of something you are pushing. I think a nail is mechanically bad because it simply stabilizes but does not give you traction across the fragments.

I wish to show that with a wood screw these fragments can be pulled up. It takes a little nick of an incision, the joint having been aspirated, a half-inch long; it is easy to do and it pulls together very tightly.

ROSCOE C. WEBB (Minneapolis, Minn.): I should like to express my approval of the aggressive method of treatment which Dr. Buckner has presented and to congratulate him on his results. Fractures of the upper end of the tibia are very serious and can become very disabling. When the injured man is required to do active duty, such as is required of men in railroad service, it is harder to get them back to work than is the case with men in less strenuous occupations.

During the past ten years I have used a method similar to Dr. Buckner's except that I have used a bolt which was inserted through a small lateral incision and passed through the fragments of the upper end of the tibia and tightened with a nut and washer on each end of the bolt. The following cases illustrate the types in which I have used this bolt:

The first case is that of a man thirty-five years of age who had a fracture of the external condyle of the tibia with slight displacement. He was a crane operator who had been knocked off a car, and he required seven months for return to work after the bolting operation which restored the fragments to a perfect position. His knee functioned perfectly, but he was definitely slow in getting back to work. In this case a more conservative method might have worked with equal satisfaction, but I present this case chiefly to illustrate that even in the fractures of slight degree the method does no harm.

The second case is one which is a little more severe in which the tibia is split longitudinally and the fragments are separated about one-half inch apart. This man was a brakeman operated upon in 1930, and at that time I used an ordinary long $\frac{3}{16}$ inch bolt which costs a nickel at the hardware store. The bolt is tightened in the operating room under x-ray guidance and the fragments are perfectly restored. The patient was placed in suspension in a Thomas splint with a Pearson attachment and early motion was instituted. He also had a fracture of the shaft of the tibia which required traction, and balanced traction was applied enabling him to move his knee joint while traction was maintained according to the method which I have described in Christopher's "Textbook of Surgery." In this case, which was of the moderately severe type, the application of the bolt was distinctly helpful and useful.

The third case is of the most severe type. The man fell from the side of a locomotive and struck his knee on a rail causing very extensive comminution and displacement of the upper end of the tibia. The bone was fractured into numerous pieces, but there is a fairly good portion of the condyle on each side of the joint which is available for bolting. He was placed in suspension and balanced traction, and an effort was made to restore the fragments without bolting until some of the swelling and ecchymosis had

subsided. The bolt was then applied through two small incisions on each side of the upper end of the tibia and suspension and balanced traction were instituted with exercise of the joint as soon as he came out of the anesthetic. The slides show that he is able to extend his knee normally and flex his knee almost normally. This man returned to work as a locomotive fireman ten months and one day after injury with a perfectly functioning knee. During the winter, a year and a half after injury, he did considerable skating and at one time skated for four hours continuously. This case represents the most severe type which in my opinion can not be successfully handled in any other method than that of bolting or wiring as described by Dr. Buckner. A through-and-through method of firmly holding the fragments on either side is absolutely necessary. The use of a screw or a nail would not be satisfactory because early motion is necessary, and early motion would loosen the screws and nails.

The three cases which I have shown demonstrate that in the less severe type the bolt did no harm; in the moderately severe type the bolt was distinctly helpful, and in the most severe type it offered the only method which in my experience has produced satisfactory results. I have not found it necessary to open the knee joint in any of my cases. If there was a loose fragment in the joint or an injured meniscus, a later operation could easily remove them. The early motion of the knee joint tends to restore the upper end of the tibia and make it possible for the joint to function satisfactorily. I have used ordinary hardware store bolts with washers on each end and tightened with a nut. An ordinary bolt cutter is used to cut off the end of the bolt flush with the nut after it has been properly tightened under x-ray guidance. I have removed the bolt only in one case, and there was no special indication for the removal of that bolt other than the patient's apprehension and my curiosity. In recent years I have used an ordinary $\frac{3}{32}$ inch bolt which is strong enough for this purpose. Some of the instrument makers are now furnishing this size bolt made with nuts and washers of stainless steel.

I should like again to second Dr. Buckner's method and to insist with him that patients with fractures of the upper end of the tibia receive more aggressive treatment.

CLAY RAY MURRAY (New York City): I agree very thoroughly with the principles expressed by Dr. Buckner in his procedure for fractures of the upper end of the tibia. The ideal case is always the one in which there is a single large fragment. The cases that require operation are those in which there is disturbance of the articular surface, both from the standpoint of pain due to strain on the joint, because of malposition of the upper end of the tibia, and also because of later arthritic changes in the joint, due to the rough, irregular surface.

In many of the cases of this type on which we have operated we have found lesions of the cartilage on the affected side. We have always operated through an incision which thoroughly exposed the knee joint. Where the

cartilage has been torn loose or damaged, it has been removed at the time of operation.

One other point which has impressed us has been that when you do view the knee joint in many of the cases, particularly where comminution has occurred, although a main fragment may be pulled up into position, there are multiple small fragments which lie between the main fragment and the shaft, and give to the articular surface an extreme degree, at times, of irregularity. By reasoning of opening the joint, it has been possible to rearrange the articular surface in the gap between the main fragment and the shaft so that a relatively smooth, even surface was left. We have thought that this was a distinct advantage.

I also thoroughly agree with what Dr. Venable and Dr. Webb have said, that these cases should not be immobilized postoperatively. One advantage of fixing the fragment is that early mobilization after operation can be practiced with safety in balanced suspension, with preservation of motion, not so much from the standpoint of the ultimate result but from the economic standpoint of the time taken to secure that result and to get return to duty.

Also I agree that late weight-bearing is desirable rather than early weight-bearing. It is true, again, as with so many other things, that you can "get away" with early weight-bearing in many of these cases, but the cases that do collapse, since this is cancellous bone in which the callus remains relatively soft for a long period of time, present later distortions of the surface which are almost as bad sometimes as the original injury.

H. T. BUCKNER (closing): In regard to exposing the knee joint, I have not believed that it is necessary to do so, and in the after reports of the patients, in the forty-six that I have operated on, there has been no locking of the knee nor evidences of injury to the cartilages; and because of that I am of the opinion that it was a simpler procedure to make the small incision and put on the fixation. I do not think it matters much whether you use the bolt or the wire, but some method is very desirable in these types of cases.

In regard to the early weight-bearing, weight-bearing should not be permitted without a support, and the ring splint, I believe, is one. Many surgeons use the splint without the ring, but with weight-bearing with the aid of the ring, they get little weight on the joint itself; consequently, it permits function of the leg and early restoration.

SOME OBSERVATIONS ON FRACTURES OF LONG BONES IN CHILDREN*

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DURING the last ten years 2,094 fractures of the long bones have been treated on the Children's Surgical Service at Bellevue Hospital. All of the children with these fractures were under thirteen years of age and all were admitted to the wards of the Hospital. Fifteen hundred and fifty of these fractures, or 75 per cent, were of the long bones of the upper extremity. The radius was the bone most commonly fractured, being injured in 933 cases, an instance of 45 per cent. The next bone in frequency was the humerus, with 404 fractures, an instance of 19 per cent. The tibia came third in frequency, with 323 fractures, an instance of 15.5 per cent. The femur was fourth, with 189 fractures, an instance of nearly 10 per cent. Fracture of the clavicle, which is said to be so common during childhood, was in fifth place, with only 153 cases, an instance of but 7.6 per cent.

We believe that the treatment of fractures in children requires a special training. A knowledge of the structure of the bones during the successive pre-adolescent years is of the utmost importance for one who is to treat fractures during childhood. Without this preparation the surgeon is unable correctly to interpret x-ray findings or to select the most advantageous method of treatment. Besides this special anatomical knowledge, he should also know the manner of growth of the bones of the skeleton, otherwise a useless operative risk may be taken or an erroneous prognostic forecast may be made. Nature, through growth of the bone, does much to eliminate deformities that are the result of faulty position of fragments. Examples of this will be shown by us. Finally, the young surgeon should have had some practical training under the supervision of one who is experienced in this type of surgery, as judgment is as requisite in this form of practice as it is in any other special field of medicine.

The shape of a long bone of an infant differs but little from that of an adult; though its extremities are proportionately thicker, its conformation is much the same as that of the matured bone. How-

* From the Children's Surgical Service, Bellevue Hospital.

ever, because of our familiarity with the depicted outline of an infant's bone, as observed in roentgenograms, we naturally may picture the bone in our minds as a shaft with small, rounded extremities which are separated from the neighboring bones by wide joint spaces. This aberration, however, is apparent only in the roentgenogram, because the x-ray easily penetrates the cartilaginous epiphyses, leaving only an impression of the osseous tissue upon the sensitized film. Some years later the centers of ossification appear in the epiphyses and these cast their shadows from the x-ray as rounded masses. Still later, the epiphyses become fully ossified and their outlines are completely shown, except for the epiphyseal line which represents the position of the conjugal cartilage.

Fractures through the cartilaginous epiphyses of the long bones are not altogether uncommon. The epiphyses of the distal extremity of the humerus are those most frequently injured; but, because of the failure of the x-ray to visualize the loss of continuity in cartilage, a fracture of the epiphysis in a young child can be detected only by means of the physical signs that may be present. In the case of older children, in whom the centers of ossification have appeared, though a fracture line is not discernible in the roentgenogram, the displacement of the fragment can often be ascertained by noting disturbances in the relationship of the centers to one another or to the metaphysis. This condition is most often found in fractures about the elbow joint. It seems evident that if this method of diagnosis is to be used the surgeon must not only be skilled in interpreting physical signs, but should also be acquainted with the development of the bony centers of the epiphyses and to the relative position of their shadows to that of the diaphysis and to one another as observed in roentgenograms. The following case is given as an illustration:

A boy, two years of age, was admitted to the Children's Surgical Service, Bellevue Hospital, having injured his left elbow two days previously. On physical examination the soft tissues covering the lateral surface of the elbow joint were found to be ecchymotic and swollen; lateral motion was present and a mobile fragment could be felt beneath the skin. X-ray examination showed this fragment to consist of an elliptical mass, about 1 cm. in length and $\frac{3}{4}$ cm. in breadth, which lay laterally and dorsally to the metaphysis. (Fig. 1.) A diagnosis of fracture of the lateral condyle was made. Attempts to obtain reduction failed and the child was operated upon. On exposing the fragment it was found to be an irregular mass of cartilage and bone which was easily recognized to be the lateral condyle, composed of a fragment of bone from the diaphysis, representing the

epicondyle and juxta-epiphyseal region of the lateral half of the metaphysis, and the lateral half of the epiphysis, laid down in cartilage (for the center of ossification for the capitellum had not as yet appeared). This fragment,



FIG. 1. Fracture of the lateral condyle in a child two years of age.

to which the extensor muscles of the forearm were attached, had been rotated so that it could not be replaced until its axis was straightened.

Longitudinal growth of a long bone occurs through the proliferation of the cells in the epiphyseal cartilage plate. Haas has shown that the proliferating cells which produce growth are those that border upon the epiphysis and, consequently, that damage to the epiphyseal

surface of the cartilage plate produces cessation of growth; while injury to the juxta-epiphyseal region of the metaphysis does not necessarily effect growth. These findings are substantiated by clinical experience.

The periosteum of the child is not as firmly attached to the cortex of the bone as that of the adult. Consequently, it is often stripped from the surfaces of the fragments in fractures, forming a tube-like bridge between the fragments. This, as will be shown, guides the formation of callus across gaps between the fractured surfaces, thereby re-establishing the continuity of the bone. Meanwhile, the misplaced ends of the fragments become absorbed. Thus a malalignment often becomes obliterated. Aitken has demonstrated this remarkable remodeling of bones in children following fractures, in reports on the end results of fractures of the distal radial epiphysis, the distal tibial epiphysis and the proximal humeral epiphysis. Some examples have also been published by us.

A separation or dislocation of an epiphysis should be considered as a fracture through the metaphysis. Often the fracture line is irregular and a small fragment of bone from the metaphysis may be found to be separated with the displaced epiphysis. Microscopic investigation in these cases shows us that the line of separation passes through the soft new bone of the juxta-epiphyseal region. Many of the malalignments resulting from epiphyseal displacement, as in fractures through the metaphysis, if not reduced become corrected by the processes of Nature within a few months through the deposition of new bone on the one surface of the shaft as, simultaneously, the bone on the opposing surface is absorbed. Such deformity or shortening that may occur in this type of injury is due in almost all cases to damage of the actively growing cartilage plate. Aitken has said, "Malposition of the epiphysis per se, is not a cause of deformity." This statement has been borne out by our experience.

A fracture through the juxta-epiphyseal region, causing a separation of the epiphysis, does not necessarily damage the cartilage plate. If, however, the line of fracture passes across the plate, the damage to the cartilage cells bordering upon the epiphysis usually results in a cessation of growth, causing a shortening of the bone or a varus or valgus deformity. A fracture of the bony epiphysis itself may also damage the proliferating cells of the cartilage.

Incomplete fractures are much more common among children than older individuals. They are of two varieties: subperiosteal fractures through the metaphysis (as exemplified by certain fractures of

the radius or tibia), with no displacement, and the so-called "green-stick" fracture of the shaft, in which there is a bowing of the bone. To restore the axis of the bone in the latter type, the fracture should

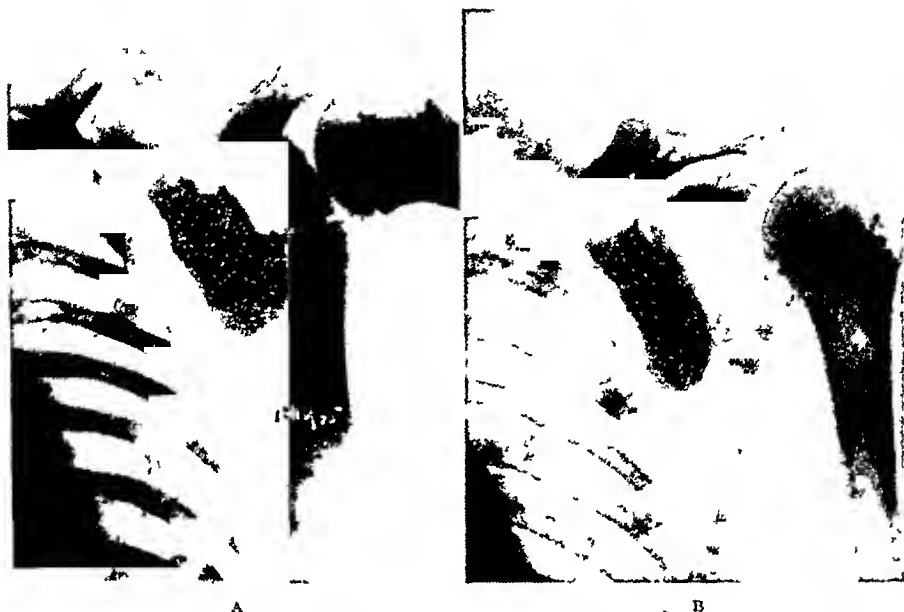


FIG. 2 . A, compound fracture of the outer third of the clavicle; fracture of body and neck of the scapula. B, end result. (From Beekman, Fenwick. *Fracture Dislocation of the Clavicle*. *Am. Surg.*, vol. 105, No. 3, 1937.)

be completed, otherwise refracture or deformity almost always recurs. Delayed or nonunion in simple fractures during the period of childhood are extremely rare occurrences. During the last ten years we have not seen a single instance of nonunion in any simple fracture in this series of over 2,000 cases.

Fractures of the clavicle in children occur in the middle third of the bone; most of them are the so-called "green-stick" variety. Even though reduction is obtained, deformity invariably recurs, as it seems to be impossible to obtain satisfactory immobilization. Nevertheless, the end results we find are excellent. The malalignment is eventually corrected, excess callus is absorbed, and full length is re-established during growth. The following remarkable case is reported:

A boy, eleven years of age, was crushed between a truck and a wall. He was admitted to Bellevue Hospital suffering from shock. There was a wound in the left supraclavicular fossa from which there was copious bleeding. A roentgenogram showed a fracture through the mid third of the clavicle and a dislocation of its acromion end. The fragment lay in a vertical position. There was also a fracture of the body of the scapula which ran across its

neck. (Fig. 2A.) The hemorrhage was controlled by means of pressure and the arm was bandaged to the side. Forty-eight hours later the arm was abducted to a right angle by means of light traction. At the end of four weeks the formation of callus was observed bridging the gap between the end of the proximal fragment and the acromion process of the scapula. On discharge, a week later, full function had returned and there was only 1.5 cm. of shortening. Three years after the accident, the alignment was perfect; the bone, though a little thickened, was not shortened and the displaced fragment has been almost all absorbed. (Fig. 2B.)

The most common injury about the shoulder joint in children, with the exception of fracture of the clavicle, is fracture of the upper end of the humerus. In this series there were forty-four such cases, 11 per cent of all the fractures of this bone. The separation of the proximal epiphysis is most often encountered in children over twelve years of age. There was no such injury observed in our cases. The common fracture in younger children is a transverse one at a lower level than that usually observed in the adult, though fractures of the surgical neck are occasionally seen. In some of these cases there is little or no displacement. It is our opinion that unless there is actual overriding, attempts to obtain reduction are unnecessary, as only too often such attempts may end in failure. The final anatomical and functional results in all these cases of fracture of the proximal end of the humerus in this series were perfect within a few months' time, even though malposition had not always been corrected.

A boy, ten years of age, was admitted on June 25, 1933, with a transverse fracture of the left humerus. (Fig. 3A.) The line of fracture was about $1\frac{1}{4}$ inches below the epiphyseal line, the proximal fragment overriding it for about 1 inch. Attempts to lock the fragments failed. Traction and suspension were then used, without effect upon the position of the fragments. One month later there was firm union and full function had returned. An x-ray showed callus bridging the gap. Four months later the normal anatomical outline had been re-established and there was no evident shortening of the bone. (Fig. 3B.)

For the treatment of these fractures of the proximal end of the humerus we have usually used traction, with the arm abducted to 90° from the chest; but now we believe this to be unnecessary in most cases and that by the use of a sling or through bandaging the arm to the chest, a satisfactory result can be obtained. Again we quote Aitken, "The author wishes to emphasize the fact that mal-

position is corrected within a month. Deformity and shortening are due to damage to the actively growing cartilage plates."

Fractures of the shaft of the humerus are not uncommon. There



FIG. 3. Fracture of proximal extremity of the humerus, showing realignment of bone through the effects of Nature. (From Sullivan, John E. Injuries about the shoulder joint in children, exclusive of fracture of the clavicle. *Ann. Surg.*, vol. 7, No. 4, 1938.)

were fifty-eight cases in our series, 14 per cent of the fractures of the humerus. Unless accompanied by an injury of the radial nerve, which is a rare occurrence during childhood (there was none in our series), the prognosis is excellent, even though there is angulation or overriding of the fragments. Fractures of the shaft of the humerus can usually be treated in plaster splints, though in the case of some oblique fractures traction is the most satisfactory method for maintaining reduction.

The distal end of the humerus is the second most common site of fracture during the years of childhood. There were 278 cases in this series, 70 per cent of the fractures of the humerus. This is one location in which it cannot be taken for granted that Nature will eventually restore the anatomical contour and function without the assistance of the surgeon, although many malalignments are corrected through growth.

The most common type of injury is the supracondylar fracture (41 per cent of the fractures found by us in this region) in which there is a posterior displacement of the distal fragment, accompanied by more or less lateral or medial displacement and some

rotation. Early reduction is of the utmost importance in preventing ischemic contracture and nerve injury; if delayed, reduction becomes more difficult and the danger of Volkmann's ischemia is increased.

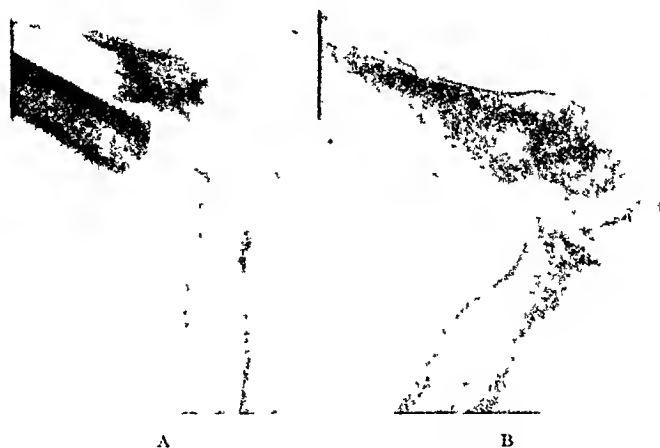


FIG. 4. A, supracondylar fracture of the lower end of the humerus. B, end result. (From Beekman, Fenwick. *Fractures during childhood. Surg. Clin. North America*, April, 1934.)

In the reduction of a supracondylar fracture, particular attention must be paid to the correction of any lateral or medial shift, or rotation of the distal fragment, as these displacements inevitably result in changes of the carrying angle. We believe it is not as important to reduce the posterior displacement as Nature corrects this malalignment, and we are satisfied if we obtain a contact of at least one third of the fracture surfaces, if lateral displacement or rotation can be overcome. Though in the past these fractures were treated with the forearm maintained in a position of acute flexion, we now use the method of traction described by Dunlop. This gives excellent results, if primary manipulative reduction is used, without the danger of embarrassing circulation.

On May 9, 1927 a boy, ten years of age, was admitted to Bellevue Hospital. He had sustained a supracondylar fracture of the left humerus three weeks previously. Flexion of the elbow was limited to 90°. A roentgenogram showed the distal fragment displaced posteriorly with overriding of the proximal fragment. A bridge of new bone spanned the gap between the fragment and the dorsal surface of the cortex of the shaft; the distal end of the shaft projected into the cubital fossa, obstructing flexion of the elbow-joint. (Fig. 4A.) A year later there was little improvement. Two years after the accident the patient returned with no limitation to flexion and but slight decrease in the carrying angle. The roentgenogram obtained

at this time showed the end of the bone remolded, the projecting end of the proximal fragment having been absorbed and the shaft prolonged to the fragment by callus. (Fig. 4B.)

Supracondylar fractures with anterior displacement of the distal fragment are far less common in children. This type of fracture (there were but three cases recorded in this series, only 2 per cent of the supracondylar fractures) is due to direct violence.

Intercondylar fractures, the so-called τ and γ types, are rare in children. The epiphyseal cartilage plates are invariably damaged in this type of injury, resulting in late deformity. Consequently, the prognosis should be guarded.

Fracture of the lateral condyle of the humerus is not uncommon (17 per cent of the fractures of the distal end of the humerus in this series). Occasionally the fragment is rotated, so that it cannot be replaced without an open operation (6.5 per cent of these fractures). If left unreduced, a serious deformity results which eventually may cause an ulnar nerve paralysis. Even though reduced, a gradual increase of the carrying angle may follow the injury, due to damage to the epiphyseal cartilage plate of the capitellum. Consequently, a guarded prognosis should always be given.

Fractures of the medial epicondyle are not unusual (16 per cent of the fractures of the distal end of the humerus in our series). They are usually epiphyseal separations and may result in an increase of the carrying angle without any loss of function. The condition often accompanies dislocation of the elbow, and occasionally the fragment of epicondyle may be displaced within the joint during reduction of the dislocation. In these cases, open operation is imperative.

Fracture of the neck of the radius is not uncommon (we had twenty-two cases, 2.3 per cent of the fractures of the radius). The head of the radius is seldom injured in children. Conservative treatment is advised unless a marked rotation or displacement of the head has occurred. Excision of the head of the radius in the growing individual always results in a marked increase of the carrying angle, radial deviation of the wrist, as shown by Lewis, and often in loss of rotation of the forearm. When there is considerable displacement, it is far better to attempt to replace the head in position than to excise it. But even then the results are not always good. Separation of the head at the epiphyseal line usually results in its closure. It is surprising to find the results obtained by conservative methods of treatment.

A boy, eight years of age, was admitted with a fracture of the neck of the right radius, together with a fracture of the olecranon. The head of the radius was slightly displaced laterally and there was little displacement of the olecranon. The right arm and forearm were immobilized in molded plaster splints for fifteen days and then active motion was started. In two months all motion at the elbow joint was complete, with the exception of full extension, which was limited about 10° . The carrying angle was increased about 5 per cent. After two years the carrying angle became normal but the defect in extension has persisted.

Most fractures of the forearm occur in the distal halves of the bones (82 per cent of the fractures of the shafts of bones of the forearm in this group occurred in the distal third). They are often "green-stick" in type and must be completed before a proper reduction can be obtained. Reduction is often difficult; it is merely necessary to obtain an end-to-end contact of one of the bones. Cross union seldom occurs (there was no such case in this series, except in one of a fracture of the neck of the radius). Recurrence of the bowing or refracture may occur if splints are removed too early. These fractures should therefore be splinted for at least eight weeks. A weak point of the radius is near the junction of the shaft with the metaphysis. Fractures at this site are common. The so-called "torus" fracture, a transverse break, characterized by a local expansion of the cortex, is frequently incomplete; but even when complete there is seldom much displacement. This type of fracture of the radius is often accompanied by a transverse fracture of the ulna at the same level.

The lower radial epiphysis is separated more frequently than any other (2.2 per cent of the injuries of the radius). But despite this frequency, damage to the cartilage plate is rare. Reduction of the fragment is usually accomplished with ease. However, if not reduced at first, repeated attempts or an open operation are seldom justifiable, as the alignment is invariably re-established. Even the plane of the articular surface of the radius is returned in a short time to its normal relationship with that of the axis of the shaft.

L. W., a boy of twelve, while skating fell upon his outstretched right hand. He had severe pain in the wrist. It was treated as a sprain of the wrist for five days, at which time an x-ray was taken which showed a posterior dislocation of the lower epiphysis of the right radius. The epiphysis was displaced by half of its diameter from the end of the diaphysis and was slightly rotated so that its articular surface was looking dorsally instead of toward the flexor surface. (Fig. 5A.) The child was seen by two surgeons

who both advised operation. Ten days following the accident the boy was referred to one of my associates, who found the fragment so firmly united to the epiphysis that it could not be moved. He advised conservatism. The



FIG. 5. A, posterior dislocation of the distal epiphysis of the radius. B, end result. (From Beckman, Fenwick. *Fractures during childhood. Surg. Clin. North America*, April, 1934.)

forearm was splinted for ten days. Fifty days later flexion was limited to 20° and all other motions were normal. Six months later the boy had normal range of motion of the wrist in all directions. (Fig. 5B.)

There have been eight cases of fracture of the neck of the femur, seven of which were treated by Russell's traction with prompt union and little or no coxa vara. The eighth case, a compound fracture, developed osteomyelitis and ankylosis of the hip joint.

There have been 150 simple fractures of the shaft of the femur. All of these have been treated by means of traction: Bryant's overhead traction to both extremities in children under four years of age, and Russell's traction in the older ones. There have been no open reductions and skeletal traction has not been used. Primary manipulation to improve position was used in many of these cases. Notwithstanding this, malposition has occurred in many. However, eventually the malalignment and shortening have been overcome through growth. It is surprising to observe how the normal alignment returns through the deposit of osseous tissue in the concavities

and the absorption of bone from the convexities of the line of union. The shortening is overcome through increased longitudinal growth at the epiphyses.



FIG. 6. A, fracture of the distal end of the tibia and fibula.
B, end result.

There were twenty-three fractures of the femoral condyles, two of which were epiphyseal separations. Good results were obtained in all.

The usual fracture of the tibia in children is through the lower half of the shaft. The tibia alone may be fractured, or there may be an accompanying fracture of the fibula. (In 273 cases the tibia alone was fractured in 185. The shaft was fractured in its lower third in 197 cases, 71 per cent.) A transverse fracture of both bones, a few inches above the epiphysis, is not uncommon and, if the fragments are displaced, reduction may be difficult. Fractures of the epiphyses occasionally occur (6.5 per cent). Fractures about the ankle, so common in the adult, are seldom seen in childhood, though occasionally a fracture of the tibial epiphysis is found with displacement of the medial malleolus. The fracture line passes through the epiphysis from the joint surface toward the cartilage plate and may damage the latter, thereby causing premature closure of the epiphyseal line with a resulting varus deformity.

A good result may be expected in fractures of the tibia, provided a fair reduction is obtained and the fragments are retained in position until union is completed. Occasionally traction may be necessary. Skeletal traction is seldom needed, for in most cases the

fracture can be treated successfully after reduction with plaster. Slipping of the fragments after reduction seldom occurs. Even though malposition is not corrected, the final results are usually good.



FIG. 7 A, separation of the distal epiphysis of the tibia; fracture of the lower end of the fibula. B, end result.

A girl, nine years of age, was admitted to Bellevue Hospital on September 21, 1935, with transverse fractures of both bones of the right leg, about 1 inch above their distal conjugal cartilages. The distal fragments were displaced posteriorly and laterally. (Fig. 6A.) Attempts to obtain reduction by means of manipulation failing, traction through a Kirschner wire was tried with no better success. Union occurred with the fragments in malalignment. In less than three months' time the malalignment had been overcome and the contour of the bones had been re-established. (Fig. 6B.)

The following case of badly displaced lower epiphysis of the tibia demonstrates the reformation of normal anatomical outline in such injuries, though reduction of the epiphysis has not been obtained:

A little girl, eleven years of age, was admitted with a fracture of the lower third of the tibia and fibula. An x-ray showed the lower epiphysis of the tibia displaced laterally, along with a portion of the metaphysis and the distal portion of the shaft of the fibula. (Fig. 7A.) An attempt was made to reduce the fracture by manual manipulation which was unsuccessful. Open reduction also failed to correct displacement. Three months later there was beginning realignment of bones and in ten months there was over 75 per cent restoration of normal contour. (Fig. 7B.) Clinically there is slight

flattening of the foot, with no deficiency of flexion or extension of the ankle and no limp.

CONCLUSIONS

Fractures of the long bones in children differ considerably from those occurring in adults. The bones in the former are growing, so Nature is kinder in healing the fractures and can usually be depended upon to correct deformities due to malalignment. But because Nature will eventually overcome deformities, which are the results of displacements, we believe nevertheless that there is no reason why the surgeon should leave the entire responsibility to her. It must never be forgotten that there is also soft tissue damage at the time of injury and that an early reduction releases blood vessels and nerves from further injury. Consequently, by obtaining an anatomical reduction, function returns more rapidly. On the other hand, repeated attempts to obtain reduction through manipulation, traction or open operation may not only be unnecessary, but may actually cause damage. For this reason, every fracture should be treated as an individual problem after all the facts in the case have been taken into consideration. Knowing that Nature will correct most displacements, the indications for an open operation or for complicated procedures for traction are far fewer than in the case of fractures in adults.

However, the very fact that a growing bone is being dealt with may be the cause of disaster which, with our present knowledge of growth, we are unfortunately helpless to prevent; that is, in those cases of fractures which involve the cartilaginous parts of the epiphyses. These injuries may not be discovered by x-ray and, for this reason, the clinical signs are of the utmost importance in reaching a diagnosis. Further, though the fragments may be entirely reduced, deformities may slowly develop during growth, due to damage of the proliferating cells of the epiphyseal cartilage plate.

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DISCUSSION

ALEXANDER P. AITKEN (Boston, Mass.): The obvious conclusion to be drawn from this paper by Dr. Beekman and Dr. Sullivan is that in the treatment of fractures of childhood we must be most conservative.

Their conclusions, of course, are based on several years' experience in a large municipal hospital where hundreds of children's fractures are seen.

At the Boston City Hospital we, too, see hundreds of fractures during the course of a year, particularly in children, and we, too, have arrived at the same conclusions.

As Dr. Beekman has said, since 1933 we have been particularly interested in epiphyseal fractures and have written a great deal on that subject. As a result of our studies, we have come to very definite conclusions. One of the slides Dr. Beekman showed you demonstrated three types of epiphyseal fractures. We believe all epiphyses are subject to these types of fracture, and that deformity is due to the type of fracture received and not to malposition. Deformity is due only to injury to the cartilage plate at the time of injury, or from operative attempts at replacement. Malposition in extra-articular epiphyses is very readily straightened out and deformity as a result does not occur. In intra-articular epiphyses, of which there are three, the external condyle, capital-femoral and proximal radial Nature does not correct malposition; consequently, displacements of these three epiphyses should be promptly operated upon. I say that although I have yet to see in fractures of the proximal radial epiphyses (which are intra-articular) a good result once it has been displaced.

I have just one slide to show. This is a case of a Type 1 fracture in a child that entered the City Hospital six weeks after his injury with considerable displacement. Not only is the epiphysis displaced three-quarters of the width of the shaft, but also rotated about 60 degrees. We attempted reduction but were unsuccessful. We left it alone, with our fingers crossed, and took x-ray plates every six weeks. This picture was taken six weeks after admission and even at that time the sharp end of the diaphysis had been rounded off and already a new shaft was being built out to the displaced epiphysis. Twelve weeks later there was still further remodeling of the end of the diaphysis. Progressive correction was seen at the end of eighteen and twenty-four weeks. At the end of one year after injury, unless you notice the absence of the normal volar curve, it would be very difficult to tell which epiphysis had been fractured.

Dr. Beekman has shown you what nature will do in long bones. We have seen marked bowing corrected in the shaft. That brings up the ques-

tion as to whether we are justified in operating upon fractures of the shaft with shortening. Will Nature make up for the shortening of a long bone?

Recently at the City Hospital we have studied seventy-one cases of fracture of the femoral shaft in children by means of four-foot films, so that we can get fairly accurate measurements of the shaft. When a shaft of a bone is broken, we get the formation of callus and there is a marked hyperemia of the periosteum as long as the callus remains. The epiphyses get all of their blood supply from the periosteum; consequently, fracture of the shaft produces a hyperemia of the periosteum and consequent hyperemia of the epiphysis. Under twelve years of age this results in an increase in the growth of the epiphysis with consequent elongation of the shaft.

This overgrowth is not compensatory, for not only will fractures with displacement show overgrowth, but also fractures that are anatomically reduced. The average overgrowth has been 1 cm. In general, the more displacement, the larger the callus, the longer the callus persists, and consequently the greater overgrowth we get.

In anatomical reductions, particularly those in which open reduction was done, we have had sufficient overgrowth of the femur to cause a tilting of the pelvis with a compensatory scoliosis. From the point of view of orthopedies, the scoliosis did not amount to much but, nevertheless, it was present. In other words, in fractures of the long bones with displacement, we can be sure that the original shortening on discharge will not persist. A great deal of it will be made up in the normal overgrowth which occurs in every fracture. If we have displacement up to half an inch, there is a question as to whether or not we are justified in doing open reduction. As long as we have malpractice, I suppose we are justified, but cases certainly in our experience, with a half inch overriding, by the end of a year will have made up that shortening. In subperiosteal or fractures without displacement, or when open reduction has been done, we can be sure that lengthening will occur.

Some will say when the child reaches full growth that the two legs will equalize. We have nine cases in which ossification of the epiphysis is complete and those patients have maintained their overgrowth.

JOHN A. CALDWELL (Cincinnati, Ohio): The particular features seen in fractures of long bones in children which have been stressed by Dr. Beekman accord completely with our experience at the Cincinnati General Hospital Fracture service.

Several years ago we reviewed our cases of fracture of the femur in children. The total number was 443 and there was no open operation in any of these. This did not mean that we had good position in all cases, but even when the relation of fragments was poor, the final result was good. None of these cases had any impairment of function or deformity.

The outstanding case occurred in 1916. In spite of all efforts short of open fixation, it united by excessive callus and $1\frac{1}{4}$ inch shortening. Exami-

nation two years later showed a slight alteration of the axis of the femur with some enlargement of the bone, and careful measurement showed the injured leg $\frac{3}{8}$ inch longer than the other.

This patient came back twenty-two years later bringing her own child to the Fracture Clinic, when measurement of the two legs still showed $\frac{3}{8}$ inch lengthening, but x-rays of both legs did not disclose any alteration of contour.

I wish to concur particularly in emphasizing the importance of replacement in epiphyseal separation. I have had two tragic results following failure to replace a displaced lower femoral epiphysis. Both were cases which I did not see until late and unclean wounds in the region of the injury prevented correction by open exposure. In one case erosion of the popliteal artery necessitated a supracondylar amputation and in the other case, thrombosis of the artery was followed by marked vascular insufficiency of the leg and foot.

KELLOGG SPEED (Chicago, Ill.): In corroboration of what has been said, I should like to show a few slides, entering a plea for delayed and possibly minor operative procedures.

FENWICK BEEKMAN (closing): There is very little for me to say in rebuttal because I think that most people who have discussed this paper agree with us in principle. I want to thank those who have discussed it today.

The fracture that causes the greatest amount of worry is the fracture of the neck of the radius. In these we have tried all types of treatment. We tried at first, many years ago, the excision of the head, and had very poor results, increased carrying angle and a change in the wrist. We then attempted in a few cases to replace the head but were not successful in getting good results. We find that unless the head has been completely rotated in its plane, it is best to leave it alone. No one, I believe, should be in a hurry to go in and remove the head of the radius in a child.

PRIMARY OPERATIVE FIXATION IN FRACTURES OF THE LONG BONES IN ADULTS*

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THERE is probably no subject in the field of the surgery of trauma today so characterized by grave differences in opinion and practice as that of the operative fixation of fractures. Study of the literature on this subject covering the last twenty-five years, familiarity with the procedures which have been and are used at operation and during the after care of cases in many sections of the country, personal discussions with many of the men who have been either for or against the practice over the same period of time and an intensive study of the subject for the last twelve years conducted by the Fracture Service of the Presbyterian Hospital, have all made it appear distinctly worth while to present an evaluation of the situation at the present time.

The reason for a great deal of the difference in opinion as to the value of the procedure lies in what might be called language difficulties. "Open reduction" means little or nothing unless the procedure and the postreduction treatment are rigidly defined, and unless the underlying purpose of operation is clearly understood.

Particular attention is directed at the outset to the fact that this paper does not urge or advise the widespread adoption of primary operative fixation of adult long bone fractures *except under certain definite conditions*. When and where these conditions cannot be established, it advises *against* the procedure and advocates operative fixation only by virtue of necessity.

This leads to the first basic problem: What is the purpose of operative reduction? In attempting to answer this question we must immediately define two broad groups of cases. One group comprises those patients who are operated upon *by virtue of necessity*; the other group is composed of those patients subjected to primary operative

* From the Department of Surgery, College of Physicians and Surgeons, Columbia University and the Fracture Service of the Presbyterian Hospital. Read before the American Association for the Surgery of Trauma, Atlantic City, June 8, 1940.

reduction *as the method of choice*, although amenable to other and more conservative forms of treatment.

In the first group the necessity for operation may be forced by: (1) fixed interposition of tissue between the bone ends (muscle, fascia, periosteum, or loose bone fragments) recognized at the outset by clinical evidence or later on by failure of union; (2) failure to secure adequate reduction by fair trial of more conservative measures over a reasonable period of time; (3) common and accepted knowledge that satisfactory end results can be secured *only* by operation—such cases as fractures of the patella, olecranon or radial head, with wide separation of the fragments; (4) coincident soft part injuries (nerve, vascular or joint) which per se necessitate exploration; and (5) compound fractures. In this whole group of cases the operative reduction is dictated by the pathological conditions present, and reasonably satisfactory results cannot be expected by any other means. This group is not, therefore, the subject of our discussion, nevertheless much of what is said subsequently concerning the actual operative reduction and fixation of adult long bone fractures is applicable to it.

Our discussion deals with the use of primary operative reduction and internal fixation as the method of choice in adult long bone fractures in which it is generally agreed that more conservative measures will result in reasonably satisfactory end results. The discussion will be developed by answering the following questions:

1. Does the use of primary operative fixation of adult long bone fractures have theoretical advantages over closed methods of sufficient weight to warrant its consideration?

2. Can these theoretical advantages be translated into comparable practical benefits without appreciable risk to life or limb of the patient?

3. What conditions are essential if this is to be safely done?

4. How can these conditions be best established?

Question 1. The theoretical basis for primary operative fixation of adult long bone fractures as an optimum method.

The ideal method of treating a fracture would be to “wish” the fragments into place with concomitant abolition of all pathological reaction, to hold them rigidly fixed in place by “moral suasion,” and to allow the patient to resume his normal activities immediately. This translates itself in practical terms into early reduction with a minimum of violence to bone and soft parts, supplemented by measures designed to reduce pathological reaction in the tissues, as rigid a

fixation of the bone fragments as is possible and the institution of active function in all the joints of the part as soon after injury as possible.

These principles must be carried out insofar as possible even if closed methods are used, if the methods are to be sound. But it is obvious that closed methods, no matter how well utilized, must frequently secure reduction at the expense of considerable manipulative trauma, must often rest content with only partial reductions, must depend upon the relatively slow and inefficient means of position and physical therapy (when they can be used) for the reduction of soft part pathology, and must of necessity immobilize part or all of the involved extremity.

When pins or wires inserted into the bone are included in the immobilizing plaster to minimize the amount of joint immobilization, the reduction can be accomplished with less trauma, the fixation is more nearly a rigid one, and the mobilization of the adjacent joints may be more freely carried out. This is definitely a nearer approach to our ideal than is simple closed reduction and immobilization. But anatomical reductions in these cases may still be difficult, the fixation of the bone fragments is still relative, the pathological process in the tissues is attached only through the added amount of mobilization possible in the joints of the extremity and this latter is often only partial.

Traction-suspension in its various forms, if properly and successfully carried out, provides a near approach to "wishing" the fragments into place, allows of early attack on the pathological process in the soft parts by position and physical therapy, and provides, in some of its forms, for limited mobilization of some of the joints of the extremity. It often fails, however, to secure satisfactory reduction; it gives only relative fixation of the fragments; and if position and arrangement of the apparatus are not under constant and meticulous supervision, it may fail in all of its aims.

Pin-plaster fixation and skeletal traction both add to the story an additional risk, that of infection at the sites of pin or wire insertion. Excluding those cases in which the pins or wires are improperly used and in which the sites of insertion are subsequently inadequately cared for, this infection rate should be very low in soft parts, almost nil in the bone, and should increase in proportion to the amount of mobilization of the extremity practiced. If a statistical study is made of the rate of infection in cases in which pins and wires are used either in pin-plaster fixation or in skeletal traction in general use, it will be

found to be quite high for both soft parts and bone. This high general rate is to be laid, however, to improper use of the method and to lack of subsequent supervision, as well as to the generalized idea that the use of pins and wires in fracture treatment is a perfectly simple and harmless procedure requiring only the most sketchy observance of surgical principles and technic.

Theoretically, operative fixation is the only method of treatment which can simultaneously provide a relatively atraumatic anatomical reduction with coincident abolition of a large part of the pathological process in the tissues, rigid fixation of the reduced fracture and extremely early and full mobilization of the extremity involved. A properly done operative fixation should do much less actual damage than many manipulative procedures. If done at the proper time, it should free the tissues of much of the pathological results of the injury. Anatomical reduction can be secured. If rigid fixation and adequate dispersion of the forces acting on the materials used in fixation are obtained, it should be sufficient to allow full and active mobilization of all the joints of the extremity rapidly after operation.

It is obvious that open reductions followed by plaster or other immobilization do not enter this category. Open reductions in which the internal fixation is not such as to allow mobilization postoperatively, with safety and without fear of loss of the rigidity of fixation, should not be subjected to operation as a method of choice. Adequate and safe fixation must be attainable and postoperative immobilization should be unnecessary in order to warrant the use of the method. It is also clear that if operative reduction is accompanied by any appreciable risk of infection, or if there is any greater mortality than by closed reduction in similar fractures, the method is not justified. On theoretical grounds neither of these conditions should hold true.

Question 2. Can these theoretical advantages be translated into comparable practical benefits without appreciable risk to life or limb of the patient?

The answer to this question is "yes." It has been demonstrated in other clinics as well as in our own. In the last twelve years on the Fracture Service of the Presbyterian Hospital the staff has treated over 13,000 fractures, and has done over 600 open reductions. I say the staff advisedly, for every single case is discussed and argued pro and con by every member of the staff, either at the time of the treatment, in the subsequent ward and outpatient course, at the Friday morning Staff Conference or at Follow-Up Clinic. Free and open

discussion is encouraged at all times, and any conclusions here presented are the consensus of a group who have critically analyzed each case as a group, and are not based on the opinion of a single individual.

As practiced in our hands, the routine use of this method in comparison with closed methods under the conditions described in adult fractures of the shafts of both bones of the leg, of the femur, and of the humerus has resulted in: (1) better anatomical results; (2) fewer long-standing or permanent disabilities; (3) shortening of convalescence, as evidenced by the date of resumption of normal activities by one-third to one-half; and (4) increased speed of fracture healing and lessened rate of delayed and nonunion as evidenced by x-ray findings. In fractures of both bones of the forearm we had not devised until recently an adequately rigid fixation allowing active rotation of the radius and ulna without risk; and although the results now being attained in this group seem to parallel those obtained in the other long bones, they are not as yet numerous enough nor of long enough standing to warrant our drawing definite conclusions.

It is to be kept in mind that both closed and open methods have been carried out by the same group and under as nearly optimum conditions as could be created, and that 90 per cent of the cases have been followed after the completion of all treatment for from two to ten years by the group as a whole. Critical analyses of the individual case groups and detailed discussion of technics are being prepared, and will be published.* This paper is devoted to an evaluation of the principles involved.

After careful observation and comparison over this period of twelve years we have reached the point where we operate by choice on all adults who have fractures of the femoral shaft, fractures of the

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5. DARRACH, WILLIAM. Fracture of shaft of femur—open reduction and internal fixation. *Am. J. Surg.*, 44: 177; 1940.

6. MURRAY, CLAY RAY and HUDACK, STEPHEN S. Scientific exhibit on method and results of operative fixation of adult long bones at American Academy of Orthopedic Surgeons' meeting, New Orleans, January, 1941. Gold medal award.

tibia, and fractures of the humeral shaft, even though adequate position may be secured by nonoperative means, unless there is a definite contraindication to operation. This is subject, of course, to established and essential conditions which will be detailed below. With these conditions in effect the contraindications to operation in our hands are: (1) the patient as an operative risk; (2) skin conditions entailing risk of infection; and (3) mechanical features of the fracture itself precluding or making doubtful the possibility of rigid fixation of the fragments at operation. We have not had a mortality in an operative reduction as the method of choice in an adult long bone fracture. The infection rate in the same group of cases, with the culture of any organism whatever from any type of exudate as the criterion of infection, has been nine-tenths of 1 per cent, and the rate of infection leading to any prolongation of the patients' convalescence has been three-tenths of 1 per cent since the present technic and fixation materials have been used.

Question 3. What conditions are essential if this is to be safely done?

If operation is to be done, it is better done as an emergency and within as few hours after fracture as possible than after a wait of many hours or days. If done early before the pathological process becomes established in the tissues, and before the muscles have ceased to be elastic and have become instead extensively infiltrated and solidified, the reduction is accomplished with less trauma, and pathological products of tissue death, hemorrhage, inflammatory exudate and transudate are allowed to escape from the tissues. This, we are convinced, has a definite effect on the healing of bone. The period in which these results can be accomplished diminishes steadily through the first eight to twelve hours, and open reduction as a primary procedure definitely loses some of its value if delayed for twelve to sixteen hours after injury. In the early operation the bleeding is less extensive and more easily controlled. We are thoroughly satisfied that the risk of infection is less in the cases done within the first few hours and that wound healing is more rapid and more satisfactory. Postoperative institution of active function in balanced suspension is more readily accomplished in the patients operated upon early since there is a minimum of residual pathology in the soft part structures.

A Lane technic is desirable if it can be developed. We use it routinely. It is not, however, essential. If the Lane technic is not used, an exceedingly meticulous technic must be cultivated. The

skin must be carefully prepared and must be carefully blocked off immediately after the incision is made. Gentle handling of the tissues is much more important than speed of operation. The fingers should be kept out of the wound, and instruments should be kept from dragging over drapes, etc., in going to and from the wound. Careful hemostasis is important. A fine silk technic is better than a catgut technic. Minimal periosteal stripping, and, more important still, minimal stripping of the soft parts from periosteum, should be practiced. The approaches should, insofar as possible, be made through intermuscular planes.

In addition to the time of operation and the use of meticulous surgical technic other requirements are: (1) accurate reduction with a minimum of trauma; (2) rigid fixation of the bone fragments allowing postoperative mobilization; (3) early active mobilization in balanced suspension, starting seventy-two or ninety-six hours post-operatively and including all joints of the extremity. This must be enforced, in increasing amount and range, for short periods at frequent intervals, "every hour on the hour like the trains to Philadelphia"; and (4) early weight bearing in lower extremity fractures with brace protection until x-ray evidence of union permits the elimination of the brace support. Complete bony union and full function of the extremity should then be synonymous.

1. *Accurate Reduction and a Minimum of Trauma.* There must be not only early reduction, but adequate equipment to make that reduction as mechanically easy and as nontraumatic as possible, and adequate and extensive exposure to minimize the trauma of retraction, etc.

2. *Rigid Fixation.* The fixation must be by a material which will stand the strain of active function of the part in balanced suspension so applied as to distribute the strain on the fixation material to eliminate risk of breakage, and which at the same time is sufficiently chemically inert in the tissues not to cause any clinical evidence of reaction. We use a 19 and 9 chrome-nickel stainless steel, polished with a nonferrous buffer and passivated in nitric acid to remove surface defects and impurities. Other metals can be used, provided they meet these requirements. Cast metals may be inert, but internal casting defects make them risky to use because of the threat of breaking under the strain of functional activity and fatigue strain. Some of the metals formerly used, such as vanadium steel, broke under functional strain. The fixation must be in two planes. Rigid fixation, with adequate dispersion of functional strain, cannot be

secured with a one plane fixation. The single greatest cause of absorption and irritation about plates and screws is mechanical—lack of rigid fixation and failure to apply fixation so that the bone about the material used does not have to stand undue strain. It is necessary to use a plate which is four to five times the diameter of the bone, to fasten it by screws which go through both cortices of the bone at right angles to the plate, and to take up the torsional and shearing strains at the fracture site by screws which pass, either directly or obliquely, from one fragment through the other in a plane approximately at right angles to the plane of the screws holding the plate. The screws, plates, screw drivers and drills, and the use of them must be mechanically sound. Operative fixation in principle has been too often blamed for failures due to mechanically defective apparatus or a mechanically unsound use of the apparatus.

3. *Early Active Mobilization.* This requires a properly set up apparatus, with adequate and continuous supervision of it and the patient's exercise.

4. *Early Weight Bearing.* This requires accurate brace fitting, adequate instruction of the patient in brace walking with and without crutches and supervision of his activities until he is adept.

It becomes obvious that the surgeon who desires to use operative reduction as a method of choice must acquire the necessary mechanical knowledge and mechanical skill, and cultivate a meticulous surgical technic. He must have a technically excellent operating room and operating room personnel thoroughly familiar with the method and its demands. The armamentarium in instruments and apparatus must be mechanically adequate and its use thoroughly understood. Postoperative care to insure that functional activity is resumed and consistently practiced requires properly trained ward personnel exercising adequate supervision of apparatus and the postoperative routine of activity. Segregation of fracture cases as ward units is practically an essential to such organization.

The limits within which primary operative fixation can be safely done with benefit to the patient are here rather closely defined. They should be. In fact, it would be better were similar closely defined limits promulgated governing the use as well of pins and wires in the treatment of fractures.

If the requirements laid down in the preceding paragraphs are met, primary operative fixation of fractures of the long bones in adults is a safe procedure, giving sufficiently better end results on the

whole and great enough shortening of disability time for the injured to justify its use as the method of choice.

Question 4. How can these conditions be best established?

Any well trained surgeon, unless he be devoid of mechanical sense, can meet the requirements necessary as far as he personally is concerned with but little effort. By far the greater part of responsibility for success or failure lies in the organization and equipment provided for the carrying on of the work by the institution in which it is done. The individual who does the work will have to convince the institution that these requirements should be met. It can be done, and is being done. But until it is done in any given institution, no matter how excellent an individual surgeon may be, he may well say, "The operative treatment of fractures as a method of choice is neither a safe nor a worthwhile procedure"; but to make the statement truthful he should always add, "in my hands and in the institution in which I work."

If, in the *next* twenty-five years, there could be expended merely the time, money, and effort towards the establishment of these conditions that has been expended in the *last* twenty-five years in devising complicated ways and means of avoiding operative fixation, an optimum method could be much more widely used than it is today.

SUMMARY AND CONCLUSIONS

Operative fixation of long bone fractures as a method of choice in adults holds theoretical advantages over closed methods of treatment.

These theoretical advantages can be safely translated into practical benefit to the patient sufficient to justify its use under certain definite conditions.

The necessary conditions, can be adequately met, and have been by a number of institutions, with resultant improvement in healing time, in length of convalescence, in length of disability time and in end results over those obtainable by closed methods.

Where the necessary conditions *cannot* be met, the procedure is not justified.

Where the necessary conditions *are not* met, it is possible in many instances to establish the proper set-up with no more difficulty than is today experienced in providing for means to avoid operation.

FIXATION OF ONLAY BONE GRAFTS BY MEANS OF VITALLIUM SCREWS IN THE TREATMENT OF UNUNITED FRACTURES

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AN ununited fracture is one in which organic changes have developed which make union exceedingly improbable or impossible. If there is no evidence of union after the elapse of six months, a diagnosis of nonunion is usually justified. There are cases, however, in which nonunion may be definitely established in less than six months, and others in which union takes place after that period. In estimating the end results of treatment of ununited fractures, one should not include cases of delayed union.

For the successful treatment of these fractures, two requirements must be fulfilled: (1) secure fixation of the transplant, and (2) promotion of osteogenesis. The massive onlay graft secured with autogenous bone pegs has been employed by the senior author for approximately twenty years. The operation as originally designed by him was similar in mechanical principles to that of a procedure employed by Henderson, the differences being as follows: (1) A flat surface is created on each fragment for reception of the transplant, as little bone as possible being removed; (2) the endosteal or cancellous bone from the transplant is utilized as an intramedullary graft and is generously packed around the fracture site to promote osteogenesis; (3) only the cortical portion of the graft is used for fixation, as well as for osteogenesis, the endosteum being removed; and (4) autogenous bone pegs, rather than beef bone screws, are inserted for fixation of the graft. The details of the procedure are as follows:

An ample incision is made over the point of the fracture and the muscular and fascial planes are divided to the bone by sharp and blunt dissection. All scar tissue is removed from between the fragments. The periosteum over each fragment is incised longitudinally a distance of several inches, depending upon the extent and location of the fracture, and elevated from one-half to three-fourths' inch from the circumference. The soft parts, from which the circulation is derived, are disturbed as little as possible. The ends of the fragments

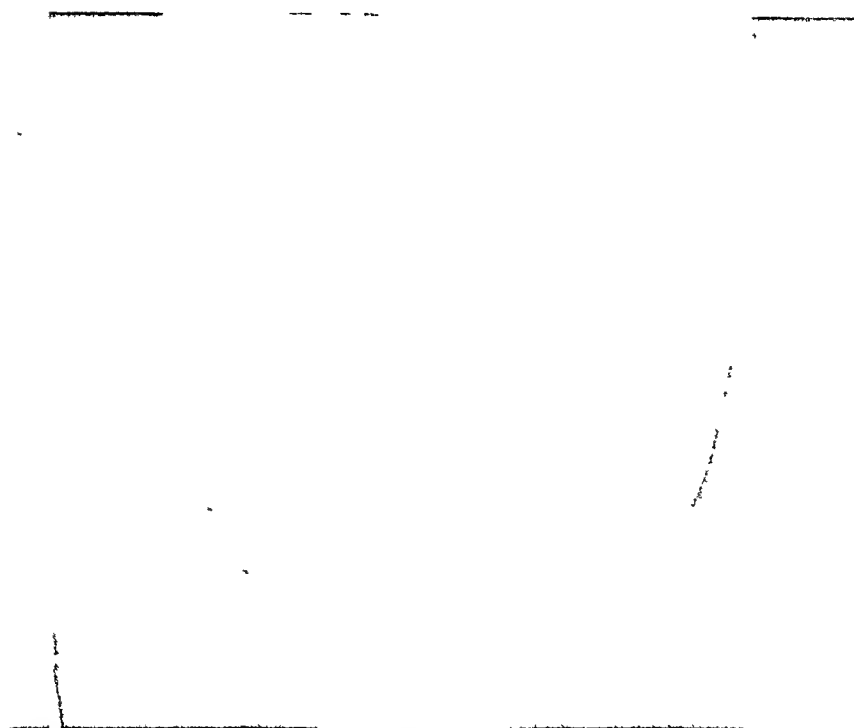


FIG. 1A. Nonunion of the femur, junction of lower and middle thirds, of six months' duration.

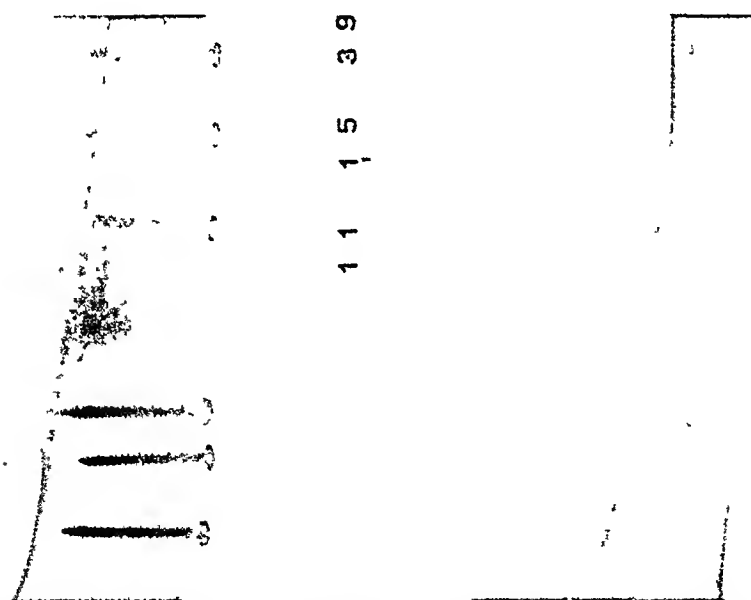


FIG. 1B. Union of the femur nine months following onlay bone graft in which vitallium screws were used.

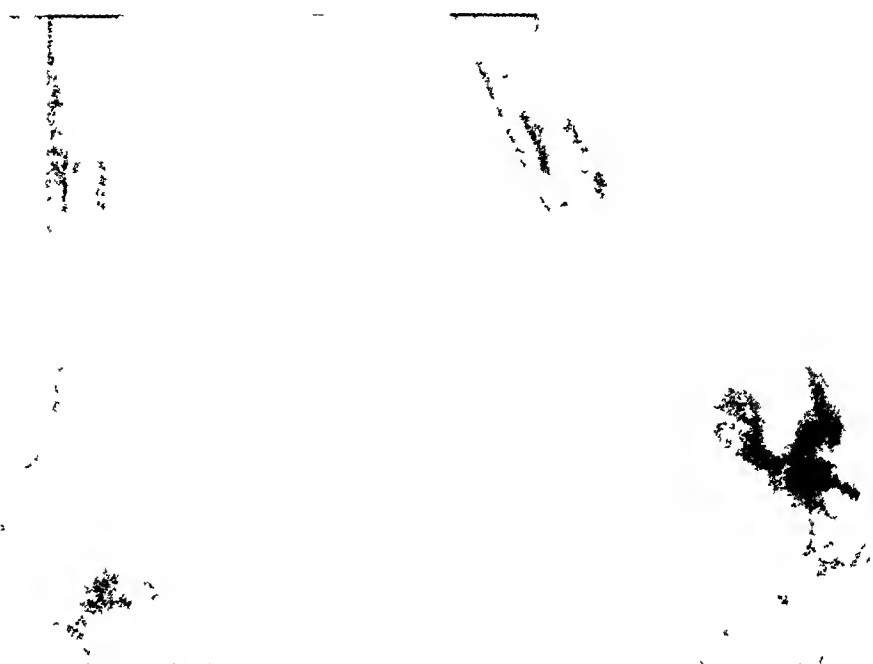


FIG. 2A. Nonunion of the humerus of seven months' duration, following compound comminuted fracture with infection and loss of bone substance.



FIG. 2B. Solid bony union thirteen months following onlay fibular graft in which vitallium screws were used.

are freshened with a chisel or motor saw and the medulla of each is reamed out until normal marrow tissue is reached. Shavings are removed from the circumference until each fragment presents a con-

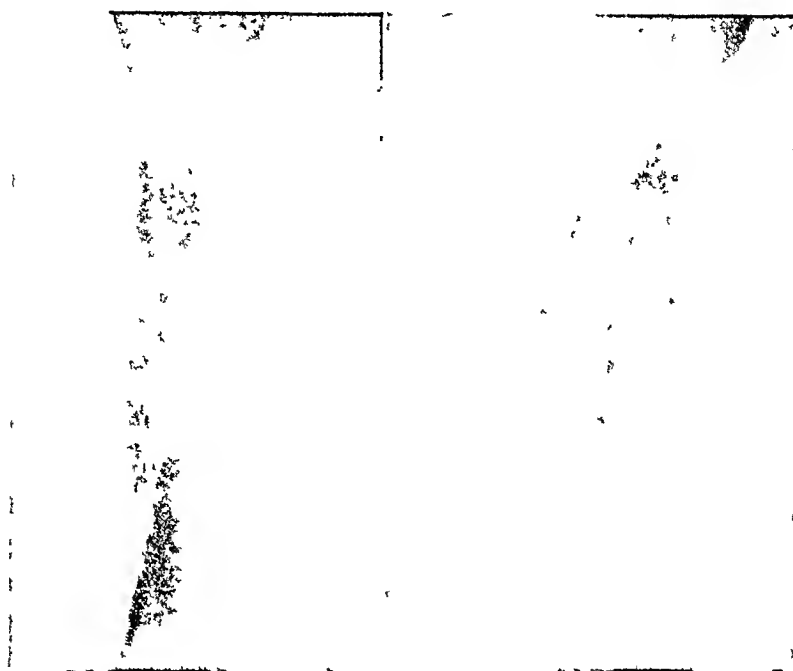


FIG. 3A. Nonunion of oblique fracture of the humerus, upper third, of two years' duration.

tinuous flat surface for a distance of three to four inches. A broad, flat massive graft of sufficient dimensions to insure firm fixation is taken from the tibia and, with a motor saw, is split longitudinally through the edge into two parts, a strong outer plate consisting of dense bone or cortex, and an inner layer, the endosteum.

As the fracture is reduced, a strip of the endosteum is inserted into the medulla of each fragment, bridging the fracture; thus, normal marrow tissue rich in osteogenic properties is restored. From the cortical segment of the graft six or eight nails of appropriate size are fashioned by means of a rotary file attached to a motor saw. A metal gauge is used for measurement. The strong outer plate is placed on the flat surface of the bone across the fracture site, and three or four holes are drilled through the graft and through each fragment, care being taken not to place the holes too close to the ends of the fragments. As each drill is withdrawn, an autogenous bone peg is inserted. The remainder of the endosteum is broken into small particles and placed with the "shavings" about the site of fracture.

The extremity is immobilized in a plaster cast or splint for eight weeks; thereafter, a convalescent brace is applied, usually in the form of a leather corset. If necessary, joints may be incorporated in



FIG. 3B. Postoperative roentgenogram shows onlay graft secured with four vitallium screws and two autogenous bone pegs.

the brace in order that motion may be instituted as soon as feasible. The brace is worn until consolidation of the fragments is complete.

In 1939, the senior author reported the end results of 261 onlay bone graft operations in which autogenous pegs were used for fixation.* Solid bony union was obtained in 235, or 93.6 per cent of these cases. Following publication of the work of Venable and Stuck,

* Campbell, Willis C. Onlay bone graft for ununited fractures. *Arch. Surg.*, 38: 313. 1939.

we adopted, in suitable cases, the use of vitallium plates in acute fractures requiring open reduction. It was soon learned that this metal was well tolerated by both the soft structures and the bone.

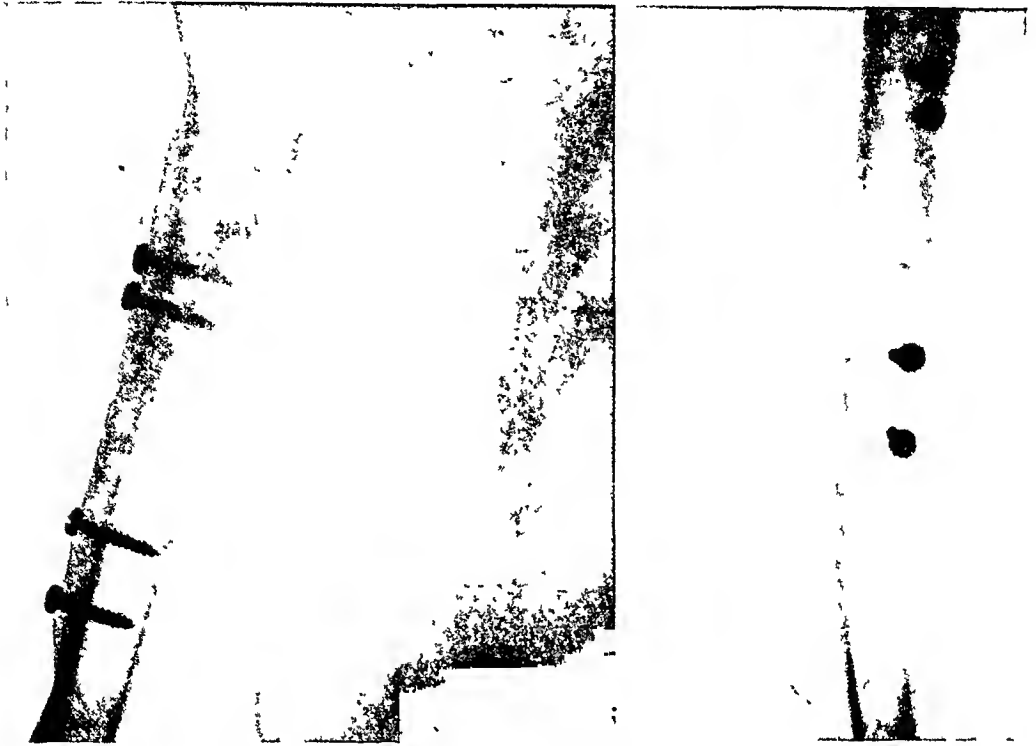


FIG. 3C. Solid bony union thirteen months following onlay bone graft.

The advantages presented by vitallium screws for the fixation of bone grafts for ununited fractures were then also recognized and the method was given a trial. The results were so gratifying that the use of autogenous bone pegs has since been almost entirely abandoned in favor of the vitallium screws. The screws have been found superior to bone pegs in that (1) better mechanical fixation of the graft is obtained, (2) a smaller amount of bone is removed from the tibia, and (3) the operative technic is materially simplified, the necessity for making the bone pegs being eliminated and the metal screws being easier to apply.

On the other hand, the use of vitallium screws possesses the following disadvantages: (1) a foreign body, though apparently inert, is introduced into the tissues, and (2) after the lapse of a sufficient period of time, the autogenous pegs become an integral part of the bone, which the vitallium screws cannot do.

To the present time we have employed vitallium screws for the fixation of onlay bone grafts in sixty cases. Forty-six of the patients were males and fourteen were females. The average age was 34.3

years; eleven of the patients were over fifty years of age. The average interval between the injury and the application of the bone graft was 16.5 months. Twenty of the patients had had one or more previous operations.



FIG. 4A. Nonunion of the humerus, junction of middle and lower thirds, of seven months' duration

The location of the fracture in the sixty cases was as follows: tibia, twenty-two; humerus, fourteen; radius and ulna, nine; ulna alone, six; femur, five; clavicle, three; radius alone, one. Nonunion of the clavicle is rare and the unusual number observed in this group can only be attributed to chance. This is an illustration of the erroneous conclusions which may be drawn from a small series of cases.

In sixteen of the sixty cases the operation had been performed too recently for the establishment of union. In all of these, however, union will probably take place, since thus far no unfavorable signs have been detected. The fracture has failed to unite in three cases, although a sufficient time has elapsed since the operation. In one of

these union may yet occur; for statistical purposes, however, it has been classified as a failure together with the other two. Forty-one of the patients have bony union. Thus, in forty-four cases, amput



FIG. 40. Onlay bone graft secured with six flange screws, two on each plate, operatively. Union was clinically evident at the time.

time has elapsed to permit an estimation of the end results. Union is solid in 93.2 per cent of these, and in 6.8 per cent, including the one doubtful case, the operation was unsuccessful.

Of the eleven patients over fifty years of age, six have secured union. The operation was performed too recently in five to justify a statement as to the end results; there are, however, no indications that any of them will fail to secure union.

Fifteen of the patients gave a history of a previous infection, either following a compound fracture or following a former operation. In five of the fifteen the infection was relieved at the time of the bone graft operation, and, in addition, four other patients developed infection postoperatively. Six of the nine patients with infection obtained union. Two failed to obtain union. The outcome of the

operation in the third is still doubtful, as the graft sequestered and was removed; at operation, there was only slight motion at the fracture site and it is believed that union will occur.

A modification of the onlay bone graft operation with fixation by vitallium screws has been employed by one of us (H. B. B.) in the treatment of congenital pseudarthrosis. A long graft is removed from the tibia of one of the parents and cut in half. After exposure of the pseudarthrosis, one homogeneous graft is placed on its medial side and the other on its lateral side. Long vitallium screws are inserted through both grafts and the affected bone for the purpose of fixation. The space about the fracture and between the grafts is filled with endosteum, which has been previously removed from the graft and from the upper portion of the donor's tibia. Union has taken place in all of the three cases of congenital pseudarthrosis in which this method was employed.

Union was secured in 93.2 per cent of the patients in this series as compared with 93.6 per cent in the series formerly reported wherein autogenous bone pegs were used. From these data, it would appear that the percentage of union will not be affected by the substitution of vitallium screws for autogenous pegs.

CONCLUSIONS

1. The use of vitallium screws rather than autogenous bone pegs for fixation of onlay grafts simplifies the operation.
2. Better mechanical fixation of the graft is afforded.
3. Union is obtained in practically an equal number of cases by the two methods.
4. The theoretical disadvantage of introducing a foreign body has little actual significance, as vitallium is apparently inert in the tissues.

THE USE OF VITALLIUM APPLIANCES IN COMPOUND FRACTURES

CHARLES S. VENABLE, M.D. AND WALTER G. STUCK, M.D.
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IN the first World War there were, of course, many severe compound fractures with gross infections, osteomyelitis or gas gangrene which resulted in great loss of life and limb. To combat these infections, the débridement technic of Baron Larry was revived, the Orr method of adequate drainage was perfected and the Carrell-Dakin plan of wound sterilization was evolved.

Since the War, highway accidents have increased in frequency and severity, and fractures in industry have become so common that the treatment of compound fractures has become a major problem of traumatic surgery. In the past few years two new principles of treatment have been developed which supplement the earlier methods and which offer hope of constantly improved results. These factors are:

1. The proof that sulfanilamide acts as a local bacteriostatic agent when placed in compound wounds.
2. The fact demonstrated by us in 1936 that metals which are electrically passive (inert) in body fluids (electrolyte) can be used with safety in the internal fixation of fractures.

I. LOCALLY APPLIED CRYSTALLINE SULFANILAMIDE

The discovery that sulfanilamide is an effective bacteriostatic agent has produced revolutionary changes in all fields of medicine and its use has become widespread. Shortly after it became available in this country, Bohlman tried giving the drug orally in cases of compound fracture to reduce the likelihood of secondary infection.^{1,2} This prophylactic measure met with such success that it gained wide popularity. Later Bohlman,^{1,2} Sinclair,¹² Chandler,⁴ Nelson, Johnsrud and Johnson,⁸ experimented with the introduction of pure crystalline sulfanilamide into compound wounds to enhance the bacteriostatic effects. This was found to produce high local concentrations of the drug in the wounds which prevented the development of osteomyelitis or gas gangrene. Sulfanilamide in a wound acts as a chemical deterrent to bacterial growth which thus permits the normal body defenses to overcome invading organisms.

In our series there have been fifty-six compound fractures which were treated with local application of crystalline sulfanilamide with infection of the bone in only two cases.¹⁴ One of these patients had received a severe crushing injury of both bones of the leg, and the other had an extensive compound fracture-dislocation of the ankle, yet even in these osteomyelitis was not extensive.

As is well known, the exposed surfaces of wounds quickly become sealed so that bacteria are retained within the tissues at the wound site. Hence it is important that the infecting organisms must be prevented from growth in such wounds. A saturated solution of sulfanilamide in serum in a wound is nearly fifty times as concentrated as the amount of the drug which can reach the wound through the blood stream and is correspondingly more powerful. For that matter in spite of large amounts of the drug in a wound relatively little is absorbed into the blood stream. Since the body quickly builds a barrier against bacterial invasion the locally implanted sulfanilamide reaches the area where it is needed more rapidly than it does when given by mouth and is consequently more effective. The use of x-ray therapy to prevent the development of gas gangrene infection seems to be of value if it is used soon after the accident.^{5,10} Locally applied sulfanilamide seems to be far more effective against the gas-forming anerobes.

II. VITALLIUM FOR INTERNAL FIXATION

In all cases of compound fracture, thorough débridement of damaged tissues is of course essential and this includes changing of gloves, drapes and instruments when necessary during the operation. The wound must be flushed with large quantities of saline solution to remove scraps of foreign material and dead tissues and the fracture must be supported with casts, splints, skeletal traction or some other form of immobilization.

Since we had observed in 1937 that ununited fractures often healed following fixation with nonirritating vitallium plates, we began to apply them to fresh compound fractures through débrided wounds. The wounds were then packed open with 5 per cent xeroform gauze after the manner of Orr. Subsequently, the extremities were supported in the usual plaster casts or splints to immobilize the involved bone and the adjacent joints. (Figs. 1, 2, 3 and 4.)

We found that these wounds filled in rapidly with healthy granulation tissue while the bone healed normally. However, they often healed by scar formation which resulted in skin adherent to

the bone. Therefore, about two years ago we undertook to insert the plates and screws through a clean incision away from the contaminated area and to treat the wound sites separately. This caused



FIG. 1. Compound comminuted fractures of both tibiae. Right treated by application of vitallium plate. Left treated by skeletal traction which resulted in much less satisfactory result.

better healing at the operative site while the bone united and the open wound filled with healthy granulation tissue. The end results have been much better because fractures have healed with a minimum of delay or deformity:

Total compound fracture cases	102
Treated by x-ray (prophylactic)	28
Developed gas infections.....	0
Gas gangrene cases treated by x-ray	3
Subsequent amputation.	1
Death.....	0
Treated by crystalline sulfanilamide.	56
Bone infections.	2
Delayed unions.	2
Nonunions.....	0

In a recent study of 1,227 cases of all types in which vitallium appliances were used by sixty-one surgeons, we found that several others had been using vitallium plates and screws in compound fractures with equally good results.^{3,6,21} Of all fractures of all types

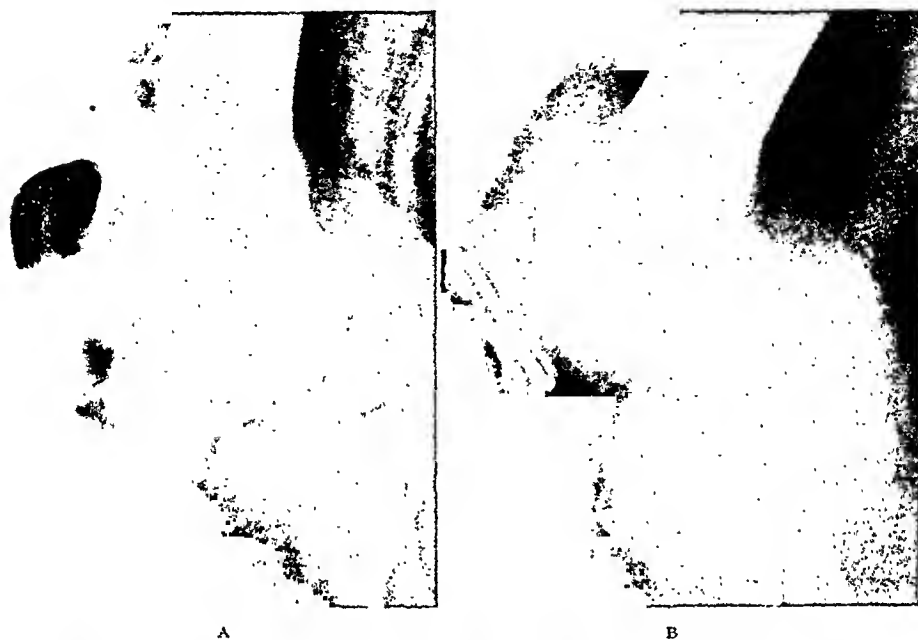


FIG. 2. A, compound comminuted fracture of left patella. B, wound débrided and fracture secured with single vitallium screw. A simple and effective method of treating patellar fractures.



FIG. 3. A, compound fracture of both bones of the lower third of the leg. B, fracture fixed with two vitallium screws. Wound packed open with xeroform gauze.

treated with vitallium appliances 92.6 per cent gained solid union, 3.8 per cent showed delayed union and 3.6 per cent resulted in nonunion. If infections developed or if the fractures failed to heal

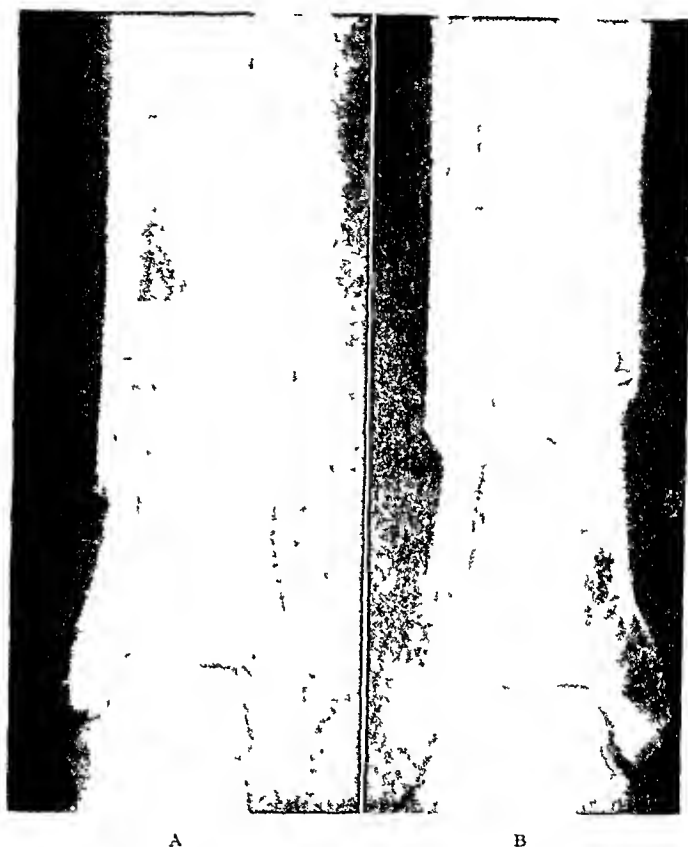


FIG. 4. A, compound comminuted fracture of both bones of the leg at the junction of the middle and lower thirds. B, wound débrided; fragments anchored with vitallium screws and wound closed. Solid union and perfect alignment four months later.

the surgeons invariably reported "the metal was not at fault." Two and three-tenths per cent of the failures were due to technical troubles in the operation.

Therefore, we find once more that the presence of an inert (passive) metal does not interfere with the healing of damaged or infected tissue or cause any "foreign body reaction." In the very few instances in which osteomyelitis developed about screws it seemed to be due to the bacteria carried into the bone by them, because healthy bone healed in about the appliances after the infection subsided.

To be sure we do not favor the indiscriminate plating of all compound fractures since many can be adequately immobilized with

Kirschner wire traction or other forms of fixation. The need for internal fixation depends upon the type of fracture, the difficulty of reduction, the severity of the injury, the condition of the wound, etc. In this, as in all decisions, conservative surgical judgment is a prerequisite.

Sulfanilamide placed directly in compound wounds provided a powerful deterring effect against growth of the contaminating organisms. Vitallium alloy has made it possible to use internal fixation in compound fractures so that the bones are held in the best possible position for good union. These developments by themselves or in combination with others offer invaluable aid in the modern treatment of compound injuries.

ELECTROLYTIC EFFECTS OF METALS IN BONE

Since we demonstrated four years ago that electrolysis must be eliminated from metals used in bone surgery this fact has become widely accepted.¹⁷⁻²⁰ Even the proponents of other alloys are beginning to speak of "pacification" of them by the creation of a protective molecular veil or the addition of molybdenum to "18-8" steel to inhibit the passage of electrons.

Sherman explained in a recent article that when his vanadium steel plates are applied to fractures a sinus may persist which requires removal of the plates and screws.¹¹ He added that the metal he used in splinting compound fractures "complicates the massive osteomyelitis." Moreover, ". . . the objections to vanadium steel have been overcome recently by the production of a new stainless steel (18-8 with molybdenum) . . . which will not corrode in the presence of sodium chloride. . . ." He was opposed to vitallium because he said it was a brittle cast metal "and contains air bubbles." Even though he stated that monel metal and duralumin corrode and "effloresce" in the presence of saline solution, Sherman denied that electrolysis could occur "when like metals are used." And finally he describes how infected wounds "usually cicatrize leaving one or more sinuses leading to the steel screws" and "this is due to corrosion or oxidation of the steel."

The sinuses leading to the steel screws indicate that an alloy is being used which has sufficient electro-activity to irritate tissues. Since electrolysis accompanies corrosion it is this action which erodes bone and causes chronic drainage. The abandonment of the highly electrolytic vanadium steel removed a great source of irritation of tissue and erosion of bone. The "18-8" stainless steel to which

molybdenum has been added is far less irritating than vanadium steel but it is incorrect to say a "like metal" is being used. Instead four metals (iron, chromium, nickel and molybdenum) are in combination and until they are more perfectly united to resist the passage of electrons there will continue to be some electroactivity about them. Uhlig and Wulff at the Massachusetts Institute of Technology have studied passivity of metals and have apparently found limitations of the oxide film theory.¹⁵ They reported that the addition of molybdenum to "18-8" stainless steel tended to complete the atomic lattice and so increase the resistance to corrosion. However, this did not produce a completely passive alloy.

Hudack, in collaboration with Darrach and Murray, has pointed out that vanadium steel causes local irritation and erosion of bone which often requires its removal.⁷ As a substitute he proposed the use of high chromium-low nickel steel as recommended by Jones and Lieberman.⁹ He remarked that if this steel is highly polished and is "passivated" in nitric acid it may gain a molecular chromic oxide coating which resists corrosion. Nevertheless, in the forty-one cases he reported plates and screws were removed in twelve because of persistent sinuses, insecure fixation, local irritation, pulling out of screws or corrosion of the metal. He concluded that this metal will be adequate when "certain requirements" are fulfilled.

THE IDEAL METAL FOR INTERNAL FIXATION

The "certain requirements" which must be fulfilled in any metal are passivity in body fluids and hence freedom from electrolytic irritative tissue effects. As we have frequently stated, a positive proof of electrolytic action (or "non-passivity") in the body is the ability to recover constituent metals of an alloy from the tissues adjacent to it. Chemical examination of tissues and fluids which have been in contact with the metal will reveal the presence of metallic ions corroded from the alloy. Thus far only vitallium is sufficiently passive in body fluids to cause no disintegration or release of metallic ions into the tissues.

We have stated before that *the amount of electrolytic disintegration of metals and consequent erosion of bone seems to be related to the current flow* recorded in a microammeter when the metals are combined with a third metal as an anode in sodium chloride. In other words, an alloy which produces many microamperes of current will produce much erosion of bone and the metal itself will disintegrate in the tissues. Thus the metals vanadium steel, duralumin, Dow

metal, etc., which cause destructive changes in the body produce more than 200 microamperes of current in saline. Stainless steel ("18-8") which is better tolerated by the body produces a reading of

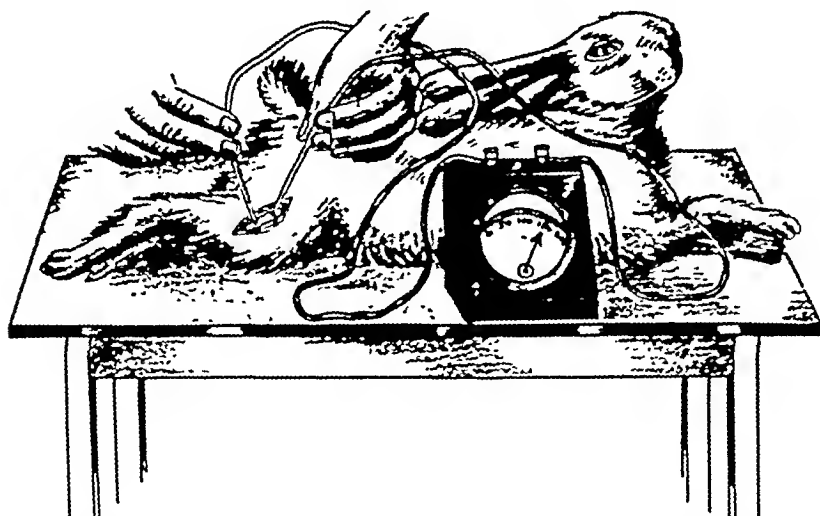


FIG. 5. Diagram showing contact being made between stainless steel screws in leg of experimental animal. Micro-ammeter shows relatively large amount of current produced.

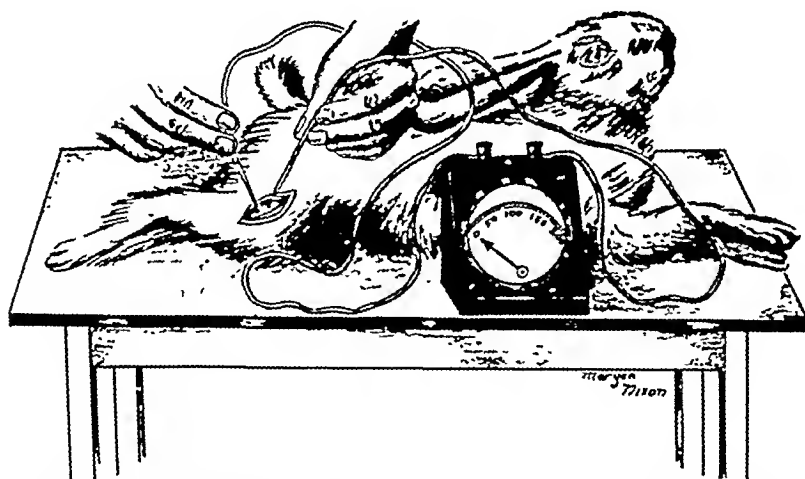


FIG. 6. Diagram showing contact being made between vitallium screws in leg of experimental animal. No current flow demonstrable on the micro-ammeter.

50 to 100 microamperes. "18-8" stainless steel which has been "passified" with nitric acid causes still less irritation of tissue and a reading of 10 to 20 microamperes. Vitallium which causes no reaction in the tissues produces a reading of 1 to 2 microamperes momentarily and then 0 amperes. (Figs. 5 and 6.)

While vitallium is the most inert alloy now used in bone surgery, we are experimenting with a recently developed alloy which seems to be approaching it in passivity. Our main interest has always been to discover an alloy which is completely nonelectrolytic and hence nonirritating in the body and at the same time malleable enough to be machined.

Experiments with "19-15" steel in which the nickel-chromium proportion is altered and molybdenum added seem to point the way toward the ultimate hope of a malleable yet passive alloy. More than a year ago we experimented with plates and screws of this new material and found that they produced only 3 to 5 microamperes of current. Screws and plates of this alloy were placed on the bones of dogs while similar vitallium plates were placed in opposite legs for controls. At the end of sixty days there were no evidences of corrosion of either metal or irritation of the tissues. Nevertheless, traces of nickel and chromium were recovered from the tissues adjacent to the "19-15" metal which shows that even this is not completely passive in the body fluids. Two similar cases of patients with mal-united fractures of the shaft of the femur were operated upon and vitallium plates and screws placed in one while plates of the new metal were placed in the other. After a year there has been no appreciable clinical or x-ray difference between the two cases. The time seems near that a material will be developed which is sufficiently passive to be used safely in the body and which, unlike vitallium, can be machined.

Such developments should be closely followed but we must reemphasize that no alloy is universally adaptable to bone surgery unless it is completely passive in body fluids. This is especially important in the treatment of compound fractures, for here of all places irritation must be reduced to an absolute minimum. Absence of electrolytic irritation makes it possible to use vitallium plates and screws in compound fractures without such corrosive manifestations as erosion of bone or sinus formation. For the time being this is the only alloy that can be used in compound wounds with perfect safety.

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DISCUSSIONS OF PAPERS OF DR. MURRAY, DR. CAMPBELL
AND DR. VENABLE

KELLOGG SPEED: My discussion really covers only two of the papers. The first is that of Dr. Campbell

Assuming that the only autogenous graft is used for a fracture failing to unite and which has been opened, pared down or guttered for the purpose of attaching the graft, we can conclude that the field of the fracture has been reduced, as much as lies in our power, to conditions resembling those of a fresh fracture. To obtain bony healing there must follow fixation and immobilization of the part until bony union has developed.

In my experience I have never found in shaft fracture of long bones an ideal method of attaching the bone graft onto the host to establish real fixation. Absorbable material certainly will not hold it. Wedging beneath guttered edges may hold in some instances. Old-fashioned metal screws of doubtful metallic origin and producing electrolytic reaction, have failed and bone pegs or screws have lacked in tensile strength and lasting qualities.

With the advent of a nonelectrolytic reacting metal alloy, firm apposition and fixation, as great as that obtained in applying a metal plate, can be obtained. Our choice for this fixation must lie in meticulous boring of the transplant and its transfixation with cortex-to-cortex fixation into the host bone as in applying a metal plate. Vitallium, electrolytically inert, may well be used. I have seen a few vitallium plates and screws which became broken during clinical use and cannot be sure whether those breaks were caused by the brittleness of the metal or the presence in it of air bubbles, as claimed by Sherman.

Sherman favors stainless steel, an alloy made of high chrome, low nickel, and molybdenum, which has a high tensile strength and which, when properly machined, affords no electrolytic reaction to sodium chloride or hydrochloride solution. In practice I have been using either vitallium

or the stainless steel screws, in a few instances mixing them. Observation on these patients to date shows no untoward reaction.

In addition to considering the chemical reactions about screws, we must not forget the mechanical necessity for adequate external splint fixation to guard the screws against cross- and rotation-strain and absorptive atrophy of bone along these tracks from continued or overgreat pressure until bony union has occurred.

As for Dr. Murray's paper, "operative treatment of fractures" may be a misnomer. Could we not say "operation in the treatment of fractures," because the operation often enters into at the most only two requirements in the care of fractures, namely, apposition of fragments and fixation.

Fixation acquired by operation is, however, often inadequate to support limb weight, and must be supplemented by external splintage and fixation of a high degree of excellency, because in case of failure of the method, the blame may quite wrongfully be shifted back to the operative portion of the case, when it really lies in inadequate aftercare.

We must look at operation in treatment from a broader standpoint, not merely as surgeons working in the protected cloister of our own too attentive hospital, but from the standpoint of treatment everywhere throughout the country, in order that we may set a proper pace and a good example.

In general, then, more care should be exercised, and better attempts made by all physicians in the care of fractures, without the intervention of the factor of operation. There remain many instances and some well recognized types of fractures which require operative help from the very start. These I am sure you can readily call to mind.

Operation is, in my experience, required more frequently in the neglected fracture often seen late after injury, than it is in recent fracture. Failure to gain proper apposition and subsequent immobilization, particularly after shaft fractures in adults, require operation. We should not delay in giving this help. Some instances in childhood, especially near the joint surfaces of long bones, similarly may be offered operation early, and their progress after mishandling may be hastened and bettered by operation.

One virtue the surgeon must cultivate is patience in his handling of the fracture after operation, and not feel that simply because he has operated, cure will surely follow. I believe there is an undue amount of fear about immobilizing fractures around joints, but it is far better to keep them quiet a long time and minimize the amount of rebellious reaction and detrimental new bone formation about the joint than to attempt too early motion with disastrous results.

I had no more idea of what Dr. Murray was going to say than you had, but you see that I know him well and that I understand his thoughts, and I concur very heartily in what he has said.

GUSTAV F. BERG (Pittsburgh, Pa.): I was especially interested in the summary just given by Dr. Venable, because I believe he is delving into a

field that has been comparatively unexplored from the standpoint of electrolysis and corrosion. It is true that we have used metals of various types for a considerable number of years, in achieving the fixation of compound fractures, but it is also true that the last word has not been said.

Dr. Venable has very learnedly and logically set forth his bases for the use of vitallium plates and appliances, and his findings are of untold worth to the profession.

We will all agree that the end result desired in the reduction and healing of compound fractures is threefold: (1) A strong fixation which insures perfect weight-bearing alignment and good function; (2) the elimination of the dangers of infections and their end results; and (3) a lifetime use of the injured part.

In my experience in the use of plates, screws or nails, resort has been made to various types of steel plates and screws; chief among these are the ones designed by Dr. Sherman, of Pittsburgh, in 1910, the Lane plate, the pioneer Lambotte appliances, and an appliance which I use occasionally in types of compound fractures, known as the Smith clamp.

In using the Sherman vanadium alloy plate for a period of twenty-nine years, I have found that the vanadium steel plates achieved a rigid fixation. It does not submit to the vibrations of the body. It does not interfere with the formation of reparative callus, nor does it produce an electrolysis or corrosion, sufficient in character to become the basis of a biochemical or corrosive change.

Metallurgical constituents of the vanadium plates are that the steel for both plates and screws shall be chromium-vanadium steel, conforming to the following requirements as to chemical compositions:

	Per Cent
Carbon	0.45-0.55
Manganese	.50- .80
Chromium	.80-1.10
Phosphorous not over	0.040
Sulfur	.045
Vanadium not under	.15
Desired	.18

The plates and screws, after forming, shall be heat treated to a hardness of not less than 43 or more than 53, as determined by the Rockwell hardness tester using the C scale and the 150 kilogram load on the diamond cone penetrator.

Chromium	18 per cent
Nickel	8 per cent
Molybdenum	1-V-38
Rockwell hardness.	1-C scale 35.3 per cent

Here are two screws that have been in the solution for a certain period of time, and they are presented for your inspection. The dates are on these.

One is dated December 26, 1939, and the other is dated February 6, 1939. I would like you to show me where there is any evidence of corrosion on the screws.

The end results achieved with the Sherman plate have been most successful, and I, therefore, believe that the use of the vitallium alloy plate appliances adds another efficient means of assistance in the treatment of compound fractures.

It is my belief that the matter of desired fixation is due less to the type of plate used and due more to the method of application of a plate to the fractured ends of the bone.

I believe that sufficient care is not used in holding the bone fragments immobile, and in holding the plate just as immobile, drilling the correct size of the hole. The one I use is the standard Brown and Sharpe one-thirty-second of an inch drill, and the screw which is to be used should be a tapping screw one-thirty-second of an inch oversize, and should be properly countersunk into the bone plate which has been used. That is very important, the drilling of the hole and the proper placing of the screw.

When all the screws are in place, they must be firmly snugged up so that there is no play between the bone and the plate and the plate and the screws. There must be no stripping of bone thread, and at no time is rough handling of the bone permitted. I should like to see the surgeon who has the mechanical ability to place properly a holding forcep on a bone, then hand it to his assistant, and his assistant be able absolutely to immobilize the same, while the surgeon drills the necessary number of holes. By the time this is done, how much of the bone that would fit the screw has been destroyed? What is the result? As the result of mechanics used in drilling and inserting the screws, considerable bone has been devitalized, and as the result of this devitalization, there is an absorption of bone which takes place around the screws, and as the result of this absorption the metal of which the screw is composed is accused of causing an electrolysis.

It is not permissible to overheat the bone in the act of drilling the holes by the use of high speed motors. I have found in my own experience that a combination bone clamp must be used in order to meet the above requirements.

Without any attempt to appear immodest, I must say that I have achieved this complete immobilization with a bone clamp which I designed. This is a combination clamp which comes apart and these are individual clamps, use one on one fragment and one on the other. After your bone is gripped by the instrument, the cross-bar is inserted. This is put on and it makes no difference where your fragment is. Your traction screw is then applied, and you start your correction of your overriding. Any lateral deviation and misplacement is corrected in the handle. If any one is interested in the clamp, I present it for your inspection.

I understand that our colleague, Dr. James H. Jackson, has designed a clamp with which he is able to secure the same result.

You can see that it is my thought that it is not much the type of plate used, as the manner in which it is used, that determines whether or not a perfect fixation shall be achieved. If, after a period of twenty-nine years, I have not been troubled with the danger of sufficient corrosion caused by the use of the Sherman plate, then I believe the proponents of the vitallium plate must admit that we have not suffered from the electrolysis or corrosion sufficient in character to bring about a destructive corrosion by the material used, and have had no interference with the union of fractures, as the result of the material used.

The absence of absorption of bone after the use of vanadium plates, in many thousand cases, during the past twenty-nine years, also must draw an admission that the vitallium plate, screw and appliances are not alone in the field. I have not been very much interested in the use of vitallium appliances, because of the uniform good fortune with the materials at hand.

It has come to my attention that there has been some criticism of the vitallium plate, and this criticism has as a basis certain metallurgical deficiencies. Dr. T. A. Carnes, of Massillon, Ohio, surgeon to the Republic Steel Company, has taken x-ray films of vitallium plates and screws, and has found concealed gases and air bubbles in both plates and screws. Some of these bubbles have been located at the head of screws, making shearing of the head a great hazard.

It is admitted by anyone familiar with metallurgy that air bubbles are not desirable, and, further, that all metals are electrolytic or corrosive to some extent.

In closing, may I again congratulate Dr. Venable for his invaluable aid to the profession. I will add that after the close of the meeting I would be pleased to demonstrate x-ray films of a patient operated upon twenty-nine years ago for a compound fracture of the right humerus, x-ray films and pictures of a patient operated upon for a supracondylar fracture of the right humerus twenty-one years ago, the bone plate still being in proper position; and the patient having absolutely no discomfort or interference with normal function. This patient was operated upon at the age of thirteen. This was not a compound fracture, however, a case demonstrating the use of the Smith clamp in compound fracture.

I should also like to demonstrate the combination clamp which is, I feel, of great assistance in the treatment of fractures. I also wish to present two test tubes containing the new type of molybdenum stainless steel screws which have been immersed in hypochloride .05 since December 26, 1939.

GORDON M. MORRISON (Boston, Mass.): Very briefly I should like to mention one or two points regarding the discussion of closed versus open treatment of compound fractures. It seems to me that there is a certain class of case where the patient is badly shocked, and we know shock and sepsis go hand in hand. In that type of case, or that classification, the closed treatment, following irrigation, should be definitely out.

One other factor that has given me trouble in the past and which I see other men getting into trouble with regularly, is that of the pinpoint compound fracture. Spinning an iodine gauze swab into pinpoint compound fractures will take care of some of them, but there is an awfully large percentage that go rankly septic, and then you have real trouble on your hands.

It seems to me that we ought to keep after the men who do not attend meetings of this sort and educate them up to that simple fact.

The manner of irrigation is important; it has a technic.

Dr. Griswold brought out what I think is a mighty excellent point, namely, that the tip of the irrigating apparatus should be placed in the bottom of the wound and the wound should be flushed from the inside out and not from the outside in. That is so self-evident that it hardly seems worth while to bring up, but in going around, occasionally one sees someone merely slopping soap and water or salt solution into the wound.

In those cases in which we have used vitallium screws for fixation, cortex-to-cortex, or used vitallium plates, we have not had any trouble with their becoming loose. It has seemed to me that there is an added factor of holding security with the vitallium screws. This holding security is mighty important in the clean cases, more so in the septic cases. I believe that Dr. Venable has made a great contribution to bone surgery.

KENNETH M. LEWIS (New York City): I just want to show one slide illustrating an onlay bone graft in a complicated case, but before showing that, I cannot help but think that some of this discussion takes some of the New York men back to a trip that we made to Pittsburgh about five years ago. Dr. Murray will remember that trip very well, and I am rather convinced that there are many roads that lead to Rome.

I remember at that time Dr. Sherman was very enthusiastic, as he had been for many years about the routine plating of fractures of the shafts of the long bones. We men in New York did not believe it could be done. Dr. Murray at that time did not think it could be done. Dr. Murray decided when he got back to New York, that he would try to duplicate Dr. Sherman's work and, needless to say, he has done a very excellent job.

I should like to say that at Bellevue, where we are working in a large city hospital, where we cannot possibly have the set-up that Dr. Sherman has and that Dr. Murray has at Presbyterian Hospital, we believe that some of the thoughts Dr. Murray has been expressing this morning should really be given a great deal of serious attention. A lot of open bone work on fractures, when necessary, can be done, and can be done with safety, if the proper organization and the proper care of details are taken care of. A special operating room for bone cases and a modified type of Lane technic are essential. Since we have adopted that on practically all services at Bellevue, we have found our incidence of infection has been less, that the

job can be done, and I think the thing Dr. Murray wanted to get across, and that many of us ought to try to appreciate, is the fact that it can be done and is not so much the question of who operates on the fracture as it is the invariable attention to details and organization which Dr. Sherman over many years has almost made classical.

I want to show this slide because it happens to be a complicated case. This man had his arm projecting out of a bus window and sustained a fracture of the humerus, together with an anterior dislocation of the head of the radius, a muscular spiral paralysis and a compound fracture of the upper third of the ulna. He was treated with traction. His humerus united. It was impossible to reduce the dislocation of the head of the radius. The head of the radius was excised, and subsequently, in about two months, there was a pseudarthrosis which developed at the site of the fracture in the ulna. The ulna was operated upon. The eburnated bone was quite extensive, which left a defect that can be seen.

The upper fragment of the ulna was in two pieces. I noticed in many of the films shown with Dr. Campbell's paper the number of screws used in the plates. I will admit here we have only one above and one below, which are too few. I am wondering whether two above and three below, provided they go right through to the cortex, are necessary.

Only two screws were used here because the upper fragment was in two pieces, and because of this we were afraid that in putting in two screws we might split it and spoil our end result. Even so it was simple to use an onlay graft with one screw above and one below. It has been retained and the patient has an excellent end result. An inlay graft would not have been satisfactory; a medullary graft could not have been used because the medullary cavity did not run up into the upper fragment.

DERYL HART (Durham, N. C.): I will say only a few words. I believe that in our work, and I think we have conclusively proved in our hospital, that the air is an important source of infection in any open wound, particularly in those involving bones and joints.

For a period of four to five years we had a great deal of trouble with infections in clean operative incisions and these could not be eliminated by the most rigid technic as we then understood aseptic technic to be. We had a number of carriers of the *Staphylococcus aureus* in the nose and throat (at times as high as 80 per cent of the general population, and also the operating personnel). This organism caused the greatest trouble, both as regards number and severity of infections.

By January 15, 1936, we had carried out preliminary tests on bacteria and animals to prove the efficiency of certain wave lengths of ultra violet for killing bacteria floating in the air or on a petri dish, had demonstrated on animals that wound healing was not impaired, and had equipped an operating room for air sterilization of this method. I would like to give you certain statistics, which I have just finished compiling.

From July, 1930, until January 15, 1936, out of a total of over 15,000 operations, we had eleven deaths from infections in clean primary incisions, all of these patients having operations of great magnitude. There were four thoracoplasties, three bone and joint operations, one radical mastectomy, two craniotomies and one radical dissection of the glands of the neck for carcinoma. All these patients except three had a septicemia with the same organism that caused the wound infection. The two cases of brain surgery did not have a septicemia but had an associated meningitis, so there was only one death without an associated septicemia or meningitis.

Since January, 1936, we have performed large clean operations (laminectomies, craniotomies, thoracotomies, radical mastectomies, arthroplasties, hernioplastics, etc.) in a field where the air is sterilized. Out of a total of 25,000 operations, we have had 2,500 performed in relatively sterile air, and out of this group of cases we have had not one death from infection.

Our deaths from infections in clean operations stopped sharply when we reduced the contamination of the air as a source of infection. At the same time, we reduced our infection rate in general surgery, and the surgical specialties, from approximately 4 per cent, most of them mild but with an associated severe septicemia and fatalities as I have indicated, to less than one-half of 1 per cent, most of which have been stitch abscesses. Furthermore, our postoperative temperature reactions, both in duration and elevation, have been reduced by from 30 to 70 per cent, being greatest for procedures of the magnitude of an extrapleural thoracoplasty and least in the operations of less magnitude such as hernioplasties. Furthermore, the amount of temperature reduction has also corresponded to the amount of reduction in the air contamination.

From January until June the air contamination is relatively high, dropping quite low during the summer months and rising again during the fall. In the case of thoracoplasties without radiation the curves found by plotting the average elevation of temperature or duration of temperature by months follows roughly a similar form. With radiation, however, the greatest reductions both in temperature elevation and duration, have been during the colder months so that the former curves are reversed, being lowest in the cooler and highest in the warmer months.

During the summer months when the air contamination is low, we have obtained little reduction in the temperature reaction, and it is our impression that contamination of the wound with bacteria-laden perspiration is one important factor in the production of this reaction.

I might say further that all members of the Surgical Staff (including the Surgical Specialties) have been given complete freedom of choice as to the use of ultra violet radiation. It is used by all of them with the exception of those on the nose and throat service who do not perform operations in which radiation is indicated. We have three of our five larger operating

rooms equipped for air sterilization and the demands for its use are so great that we are now having the fourth room equipped.

GROVER C. WEIL (Pittsburgh, Pa.): I can not help but take the opportunity of subscribing to some of the very excellent remarks in the papers presented, having come from Pittsburgh in an industrial center where we have long practiced and pioneered in the work of open reduction. However, it must not be thought that all fractures are reduced by the open method. We have long since, of course, realized the importance of instituting proper surgical measures or methods in each individual case.

Dr. Murray, I do believe, rather minimizes his own particular ability. He is rather timid about it, nevertheless; he has played the great rôle in effecting his organization, which is most important and which has brought about his marvelous results.

Just a word about compound fractures, going back to Dr. Speed's dictum of fixation, retention and return of function. We have always believed in the great importance of this. It represents a major surgical procedure, and the time period from the injury to the institution of your method is of the highest importance.

In times past I have seen many tragic deaths from gas bacillus infection; and when one considers the potentially dangerous effect of this organism within such a relatively short period of time, one can realize the importance of the institution of early treatment. We consider as one of the most important phases of the treatment of the compound fractures, the institution of early surgical interference.

We carried out the open method long before Orr popularized it. In fact, of course, he made a real contribution. With the cases left open with proper drainage following débridement—what we call sensible débridement after fixation—with, as a rule, the Sherman bone plate, it has been our observation that severe infections have been reduced to a minimum where the wound was supplied with ample drainage and dressings are delayed for weeks, followed, of course, later by secondary closure and granulation.

I have become very much impressed with the use of sulfathiazole. Dr. Venable brought out the use of sulfanilamide, but we have found sulfathiazole, particularly the sulfamethylthiazole, which we used first, was perhaps the most marvelous chemical agent we have ever used. We insufflate it in the wound, diffuse it about thoroughly, and, as Dr. Venable brought out, its application in the wound brings about a very low blood level; but its character and nature is that it is bacteriostatic, has a bacteriostatic effect, which is certainly of great importance, and we have recently been able to close up compound fractures after introducing perhaps anywhere from 100 to 150 grains. We have been able to close up these wounds without evidence of any infection.

It is too early as yet to speak of it with authority but, nevertheless, in our hands, it has certainly given great promise.

ARNOLD GRISWOLD (Louisville, Kentucky): I should like to say a few things on sulfanilamide and sulfathiazole implantation in wounds, which may be somewhat at variance with one statement of Dr. Venable and Dr. Weil. We have found that we can raise the blood concentration with both of these drugs to quite high levels by direct implantation of 5 to 15 Gm. of the drug in the wound. Taking a curve of blood concentration every two hours, following implantation in muscular structures, the blood concentration hits a peak of six to nine in about twelve hours and dies off in about forty-eight hours. When the drug is used in the peritoneal cavity, the absorption is much more rapid, and the blood peak occurs in about four hours. Our highest concentration has been a peak of fourteen, four hours after operation, and we have seen cyanosis following implantation of sulfanilamide in the wound.

CLAY RAY MURRAY (closing): I have very little to say in closing except that I should like to comment on something said by Dr. Speed and referred to again by Dr. Berg, as emphasizing my own personal convictions. In my opinion the majority of the criticisms directed at the metals commonly used in the fixation of fractures as being responsible for failure to heal and for irritation in the tissues should be directed toward the technic with which these metals are applied and the lack of absolute fixation, rather than toward the chemical composition of the metal.

Any metal put into tissues which undergoes excessive strain because of lack of rigidity in fixation, or which is loose in the tissues, or which is applied in tissues which as a preliminary are badly traumatized, is going to cause trouble, not because it is metal but because it is a foreign body in an area of inflammation. The tissue fluid changes which occur as a result of that inflammatory process are per se sufficient at times to prevent bone formation at the site of a fracture. In fact, some fracture cases result in nonunion, as we all know, without the use of any metal. The inflammatory reaction at the fracture site, if it produces sufficient change in the tissue fluids to cause prolonged marked acidity, will cause delay or failure in calcification of the healing tissue.

I agree with Dr. Berg that it is probably not necessary to have complete passivity of the metal introduced. It is ideal, unquestionably, but from my point of view in the operative treatment of fractures as the method of choice, it is not only necessary to have a metal which in itself does not cause any appreciable disturbance, but it is also necessary that that metal be able to stand the strain of function postoperatively. Vanadium steel in our hands has not been able consistently to withstand the strain of function. The breakages were few, but they were very, very disturbing.

Vitallium has no reaction in the tissues. It is a cast metal and it would appear from what work we have done with the metal that it will not stand the strain of active function postoperatively in the form in which it has now, or up to now, been put out. In other words, I think Dr. Venable

and I, while I talk in terms of stainless steel of a certain type, and he talks in terms of vitallium, are talking the same language, and have the same ideal, and I think he will admit if ever a metal is discovered which produces no physiological change, and which at the same time has the flexibility and the toughness of the stainless steels, we will have the metal which fulfills all requirements. Vitallium is not that metal in my opinion.

One other thing I think is of importance: I do not believe we have a satisfactory criterion of tissue reaction unless it is checked by physiological results. The reactions caused by metal in saline and other solutions are not adequate evidence. As to use in the body, I think one has to produce evidence that a metal is not only electrolytic, but that the amount of electrolysis produced actually produces changes in a tissue. Changes in ammeters do not affect fracture healing. On the other hand, this is partly an academic question because of the amount of electrolysis induced will depend largely on what tissue is involved. Furthermore, it is into freshly traumatized tissue, further traumatized necessarily by whatever operative procedure is used, no matter how carefully it is done, that metals are placed. It is, therefore, necessary to have a test fluid of a very low pH. Experimentally we have been able to determine the pH of the tissues *in vivo*. A pH as low as 4.5 twelve hours after injury has been recorded. In that pH any metal is much more active electrolytically than in normal saline. For that reason I believe the approach to the ideal complete passivity is a very necessary thing, and I think the investigation which Dr. Venable has done is therefore of paramount importance; but if the principle of optional operation, based on the purpose of cutting convalescence time and lessening the economic cost of injury—if that principle is to be used—a metal must be developed which will both stand the strain of active function and remain inert. Incidentally, I think that covers also in a way the question which Dr. Speed raised, in which he said that postoperative fixation must be applied.

We can lay down as a definite rule for long bone fractures in adults that rigid fixation must be secured at operation if functional activity is to be allowed postoperatively. No case should be subjected to operation as the method of choice unless we are convinced that such fixation can be secured. We believe we have demonstrated that rigidity can be secured by a two-plane fixation, and that with such two-plane fixation postoperative immobilization in plaster is not needed provided the patient is kept in balanced suspension, adequately supervised. This does not mean a resident testing the apparatus at eight o'clock in the morning and again at eight in the evening; it means apparatus adequately supervised all day.

In any fracture in which the plate or screws or other fixation material gives inadequate fixation, external immobilization becomes necessary. If that case has been operated upon as the method of choice rather than by necessity, and postoperatively it is found necessary to incorporate the part

in plaster, it was a mistake to operate on the patient provided any more conservative measure would have secured adequate position.

The fixation problem is a very major one. Postoperative care of the patient is a very major thing.

Dr. Lewis, I think, expressed in very concise terms exactly my point in reading this paper; that is, that if in the hospitals of the United States the men who are doing fracture work will devote as much time, effort and money in developing the organization and equipment of their hospitals to a point at which this work can be safely done as they now devote to the devising of ways and means and apparatus to *avoid* operation on cases, the use of the operative treatment of fractures can become much more widely spread, with a great deal of economic gain and without any increased risk of either infection or death for the patient.

HAROLD B. BOYD (Memphis, Tenn., closing): I wish to thank Dr. Speed and Dr. Lewis for their discussions of our paper.

In regard to the possibility of breaking the screws, in this series of sixty patients, we broke two screws. This may occur due to two factors: First, a defect in the screw may occur in the process of casting. Second, the hole drilled in the bone may be too small for the screw. With this in mind, we are careful to have the proper size drill for the screw to be used. A slightly smaller drill is used where the screw is placed in cancellous or osteoporotic bone than when it is placed in normal cortical bone.

Dr. Speed has illustrated how the transplant may pull away from the shaft of the grafted bone. This occurred in a few of our cases in which autogenous bone pegs were used, but has not occurred in any case in which the vitallium screws were employed. Since the vitallium screws hold the graft securely, one should take special care not to apply the transplant under tension. Undue tension on the graft may cause it to absorb or break at the fracture site. The vitallium screws do not permit slight readjustment of the position of the graft, as seen in some cases fixed with autogenous bone pegs.

Dr. Lewis' criticism of the number of screws used is well taken. In our more recent cases, we have been using four screws in most grafts; however, we still use six screws when applying a graft to the femur. I do not believe that the use of two screws, as shown by Dr. Lewis, is adequate.

CHARLES S. VENABLE (closing): I do not think I made my point quite clear concerning sulfanilamide. What I said was "proportionately" and by "proportionately" I mean that if you give a patient 150 Gm. of sulfanilamide by mouth, that is a much more serious thing than if you put 150 mg. in a wound, and, of course, there is a proportionate change as it is taken up by the blood. What I intended to say was that proportionately it may be used in large quantities with reasonable safety.

I think that Dr. Berg and Dr. Murray, Dr. Sherman—in fact, I think we have all come around to talking exactly the same language. I have shown

you today the expectancy in using a material that is passive. I have been working just as hard to find, in testing many materials that could be milled, a steel that would have all of the things in point of strength that Dr. Murray requires, that is also as passive as vitallium.

It is impossible and impractical to talk about whether a metal is electro-active or not by putting it in a bottle of salt solution. I have some that have been in three or four years and still look pretty good, but you can probably recover the constituent metals after a certain length of time. Remember that the body fluids are different from just plain salt solution. You have other elements that have effect and more effect than plain salt. The crucial test of whether or not there is any irritation or any electrolytic action can only be had by the method of recovering one or more constituents of the material, so that your chemist may tell you what the metal is made of from his examination of the body or other fluid acting as the electrolyte. What we are all trying to do, in attempting to reach the same end, is to have material that can be cheaper, that can be milled, that can be machined and which will be consistently tolerated by bone and tissue.

I think there will always be a place in surgery for vitallium. Under the stress and strain of hip cups, in the first place it would have to be a cast object and not one machined; there are variations in the mechanics of creating the appliances we need. We are all talking the same language and all I hope is that we talk it so plainly that everyone understands we are striving toward the passivity of the material and trying on that basis to find the material that will then serve both purposes of strength and passivity without any fear of irritation, so that we can go to bed and go to sleep and not worry about what is going to happen.

LOW BACK PAIN AND TRAUMA

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MAJOR back injuries sufficiently severe as to cause definite compression fractures of the lower dorsal or lumbar vertebrae, partial dislocations or fractures of one or more of the transverse or spinous processes or even fractures through the arches of the vertebrae usually are diagnosed readily by the history of injury, the physical findings and the x-ray proof of the condition. Practically always such conditions give immediate signs and symptoms of severe low back pain. In the majority of cases the above mentioned fractures are easily demonstrable roentgenologically just as are fractures in the long bones. However, in a goodly number of cases pre-existing conditions in the spine, both congenital and acquired, may so confuse the x-ray findings as to cause widely different interpretations as to the presence or absence of fractures.

When alleged injuries to the back occur without causing fractures or other bony pathology demonstrable by x-ray, our problems of diagnosis and the probable relationship to true injury become far more difficult. Here again, the congenital and acquired changes in the spine may furnish the roentgenologist and the surgeon theoretical, and often bizarre explanations for the cause of the low back pain. Often one surgeon claims that the condition has been aggravated by the injury, while another disclaims any traumatic responsibility for the condition. Consider, for example, the congenital anomalies of spina bifida occulta, the sixth and often atypically formed lumbar vertebra, the winged and elongated transverse processes of the fifth lumbar, the rudimentary rib of the first lumbar with its line of articulation frequently interpreted as a fracture, failure of fusion of the two parts of an arch with a defect so often called a fracture, or the spondylolisthesis which may or may not accompany the above condition and which is so frequently called traumatic displacement, and the numerous other anomalies which confuse the diagnostic picture. Consider further the acquired conditions in the spine which cause even greater controversy concerning the cause of the low back pain and the relationship to injury, for example:

A. Infectious spondylitis with its destructive changes, or the osteochondritis of adolescence either of which may cause changes in the intervertebral discs, and even narrowing of the vertebral bodies, the result of osteoporotic changes, which frequently are confused with compression fractures.

B. The osteo-arthritic changes in the spine usually called arthritis, but better classified as arthrosis, and which practically all authorities agree are changes typical of fair wear and tear. These changes are so uniformly found in the spines of older individuals that after fifty this is almost characteristic of a normal spine. Yet, when such an individual, after heavy lifting, develops a low back pain, there are those who invariably call the condition traumatic or claim that trauma aggravated an existing condition. Did the patient mow the grass or rake the yard the night before, or did he sleep in a draught, or did some barometric or other natural etiological factor, likewise causing his next door neighbor to have a low back pain that morning, have some influence in causing his condition?

C. Finally, herniation or rupture or protrusion of the nucleus pulposus is the newest condition to enter this field of controversy concerning the causal relationship between the low back pain and trauma.

We seem to forget that these congenital anomalies have been with the patient all his life. We forget that Schmorl, and others before and after him, found all kinds of degenerative and proliferative changes in thousands of spines examined, all attributable to the repeated, long continued traumatizing forces of fair wear and tear. We forget, as Beadle points out, that the supply of food stuffs to the intervertebral discs must be consummated entirely by diffusion through the minute spaces of the spongiosa. He states: "No wonder that the intervertebral discs show perhaps a stronger inclination to various forms of degeneration in advancing age than any other tissue of the body." It would seem just as logical to claim that a minor fall or overlifting aggravated a degenerative kidney condition or an arteriosclerosis, as to claim aggravation of a large majority of these natural degenerative changes in the spine. The fault lies with the majority of us who have sought a traumatic explanation for the subjective complaint of low back pain.

Low back pain is one of the commonest complaints known to the human race. For ages the back has been the happy hunting ground for the majority of cultists. The medical profession has awakened to this source of human suffering and has instituted many corrective

measures with excellent results. However, we must guard carefully lest our enthusiasm, especially for the surgical attack on low back pain, may carry us to such extremes that future generations may look back upon this surgical epoch with disapproval.

Trauma always has been one of the commonest etiological factors for disability. In this machine age the traumatic factors have multiplied excessively. With each succeeding decade, there is a growing tendency to ascribe the majority of low back pains to trauma. While a relative increase is undoubtedly true, yet the medicolegal and compensation factors are responsible for a high percentage of these alleged low back traumas. No portion of the human anatomy has furnished a more lucrative field for exploitation by lawyers and medicolegal experts specializing in personal injury suits.

Today there is a spreading wave of enthusiasm for the surgical attack of back pain. Coincidentally, there has been a marked stimulation for specialization throughout the profession. Justly these questions may be asked: Are the specialists in traumatic or orthopedic surgery causing too many of us to attempt to solve low back pain in the terms of trauma? Are too many of us overenthusiastic to evolve some new method of treatment? Witness just yesterday the invention of every conceivable type of back brace, and today the names already attached to various forms of back operations! Are specialists in other fields too prone to interpret the low back pain in terms of their specialty and proceed to operative intervention without first viewing the multiplicity of causes responsible for the complaint? The making of specialists and the increased technical ability to attack the human body surgically should involve a corresponding increase in general diagnostic knowledge and ability. Conversely, a broad knowledge in general diagnosis and in pathology, as related to every field of medicine, is absolutely essential for the best and most conservative specialist.

In no field of medicine is this so literally true as in the management of low back pain. Such management, to be honest and successful must be based upon: (1) A foolproof diagnosis of the cause; (2) the simplest method, whenever possible, of attacking the condition rather than some complicated method; (3) a treatment that will not enhance the seriousness of the situation in the patient's mind, for example, the chronic osteopathic patient with the proverbial dislocated vertebra; the back neurotic from too much so-called physical therapy—so-called because too often it is merely turning on the short wave for days and weeks; the chronic back case wedded to a belt or

back brace; and all the other numerous types of back neurotics; (4) avoidance of the treatment which cures the primary cause but leaves a secondary disability due to a wrong line of treatment.

Space will not permit a critical review of the anatomy of the spine and yet one must be familiar with this normal anatomy in order to understand certain variations not sufficiently recognized as potential or actual trouble makers.

The normal spine is composed of thirty-two centers, twenty-four of which are movable. Not infrequently the movable vertebrae are increased to twenty-seven. These extra vertebrae are usually in the cervical and lumbar region and are found most often in the long necked, narrow chested, *flat backed*, *asthenic type of individual*. They are significant because of the proneness of such individuals to have low back pain.

The vertebrae joined by their intervertebral discs have certain normal physiological curves where, according to Eben J. Carey, the line of demarcation between the normal and pathological is not fixed. These physiological curves can be divided into primary accommodation curves and the secondary compensatory curves. When considering low back pain, the primary lumbar curve is of great importance. The anterior convexity of the lumbar spine is biologically an accommodation curve so arranged as to help support the abdominal viscera. Its normal secondary or compensatory curve is noted by the straightening of the lumbar spines in forward flexion movements. When this normal lumbar curve becomes acutely lordotic (the angle between the fifth lumbar and the sacrum is abnormally acute), we invariably have a potentially *weak back*. When the convexity of this lumbar curve is lost or is reversed into a concave curve, we have the typical *flat back* or lumbar rounded back. This is the characteristic back in the great majority of individuals of the Stiller or neurocirculatory asthenic type, a large percentage of whom are prone to low back pain in the third and fourth decades of life. In addition, there are ligaments joining together the articulating processes of each adjacent arch, ligaments between the spinous processes and ligaments between the laminae. In low back pain these ligaments must play an important part when the normal physiological lumbar curve becomes abnormal.

There are five layers of muscles about the spinal column, adjacent and overlapping. Carey has demonstrated over 120 pairs of intrinsic muscles attached to the spine, with over one million possible pulls. Some of these muscles are intimately attached to the spine, and some

more remotely removed, but, he states, that "surrounding every vertebra there is a balanced muscular function."

It is evident, therefore, that any localized imbalance of these muscles can change the position of the vertebrae—changes which may reach the point of causing pain. Likewise, pain in some portion of the back causing a certain amount of localized spasm in the muscles may cause the patient to assume a position of ease in order to relieve the pain. The faulty position soon causes imbalance of muscle pull in other portions of the spine so that a vicious circle is established which prolongs the disability. Again, complete immobilization of the spine in a plaster cast or a back brace may so limit muscle movement, that contraction of muscle groups occurs—contractions which are extremely painful when subsequent movement is attempted. Frequently this immobilization is in a faulty position with overstretching and thinning of certain other groups of muscles, resulting in weakness. Therefore, the prolonged immobilization treatment adopted for so many back conditions, functional, disease or injury, is often more responsible for the prolonged disability than is the original condition.

Whereas, in sprains about the shoulder, knee or ankle joint, or in case of fractures in or adjacent to these joints, surgeons seem to have a very clear conception of the pathological anatomy and the importance of adapting treatment to preserve function in these joints; yet in injuries to the spine the joint problem is lost sight of too often. In the twenty-four movable vertebrae there are at least forty-eight joints and twenty-four rudimentary joints any of which may sustain direct trauma to their joint surfaces, their synovial sheaths or ligaments or may sustain the traumatizing influence of prolonged immobilization similar to other joints. For example, in a compression fracture of the spine, one may see long after the fracture is healed a permanent disability due to prolonged immobilization of these joints and soft parts in a plaster cast or back brace, a disability due to stiffness and weakness from treatment rather than from the original injury.

Finally, the intramuscular fascia and the aponeurosis covering the back muscles and, in the low back, extending down over the gluteal regions and over the ilia where it becomes attached to and is continuous with the fascia lata, is recognized today as playing a very important part in low back pain. Many of the structural changes in the lumbar region, especially lumbar lordosis, may be attributed to contractions of the iliotibial band and of the tensor fascia lata, ac-

according to Ober. Either heredity, disease or injury may be responsible for this condition.

When we consider the two primary centers and the five secondary centers from which each component vertebra develops, and the complete failure of some of these centers, or the failure of one part to fuse with its fellow, a clearer conception is obtained of the numerous congenital anomalies that can exist in the spine. These structural changes may become exceedingly confusing when endeavoring to interpret certain roentgenological findings in terms of trauma or even disease.

Among the structural conditions now receiving the greatest prominence are the derangements of the nucleus pulposus. This semi-liquid nucleus encased near the center of the intervertebral disc by the surrounding annulus fibrosus and covered over at the top and bottom by the thin cartilaginous coverings of the adjacent vertebrae—the top and bottom of the intervertebral disc spread like a drum-head over the annulus—is subject to all kinds of changes. Rupture or protrusion of this intervertebral cushion is said to be possible in any direction. When it ruptures posteriorly it may give pressure on the cord or spinal roots, thus causing definite back pain with definite referred signs and symptoms in one or both extremities. Schmorl, who is chiefly responsible for our present day knowledge of the nucleus, stated that such herniations were found in 15 per cent of the 7,000 consecutive spines examined by him at routine autopsies. He did not say that all these protrusions were sufficient to give symptoms.

Ormond Beadle, in his valuable contribution, depicts to the profession this monumental work of Schmorl of Dresden, who is chiefly responsible for our modern conception of the intervertebral disc. Beadle states: "The spine is perhaps more than any other part exposed to the daily wear and tear of functional activity and owing to the peculiar conditions this functional trauma, never in abeyance, can continue to work the most far-reaching damage to its structure without causing any noticeable disability. It is for this reason that diseases of the spine often seem so inexplicable; that the examination of large numbers of supposedly healthy spines teaches this point of view as its chief lesson. In what follows it will be the central thought." This author then describes hundreds of spines with all manner of degenerative and proliferative changes in patients with supposedly healthy spines. Large numbers of these had protrusions into the neurocanal, and yet these patients evidently had carried on active

lives with supposedly healthy spines for many years. From a study of Schmorl's work, it is evident that he never intended to give the impression that these conditions were due to one definite trauma or that they immediately follow definite trauma. He referred to "functional trauma" or the wear and tear on the spine the result of normal daily activity. In contradistinction to this, Love states that in 32 per cent of 100 cases immediate trauma was given as the cause. It would be interesting to know what percentage of these 32 per cent were compensation cases. Whereas prior to six years ago this diagnosis was seldom if ever heard, today "rupture or herniation or protrusion of the nucleus pulposus" has almost replaced the old diagnostic terms of "sacro-iliac sprain or slipping" or "lumbosacral sprain."

The latter two conditions, formerly treated by belts and back braces, were rapidly being attacked by spinal fusions when this new diagnostic entity came into the field. In the last four years reports of series of 500, 300, 100, 50, 25 or less, of laminectomies, with or without spinal fusion, for nucleus pulposus herniations or protrusions, are found in the literature. One wonders how the human race tolerated its low back pains and sciaticas prior to this marvelous operation. Unfortunately, the majority of the authors ascribe the condition as due to trauma. Many mean by this term the oft repeated minor traumas of fair wear and tear. But the legal profession abetted by too many physicians and surgeons are interpreting all manner of roentgenological defects in the spine as nucleus pulposus derangements.

The final diagnosis usually depends upon lipiodol injection into the lower spine. Air injections are being advocated but most authorities agree that the information is not as conclusive. One wonders if this iodized oil injection—and a great number of patients are now being subjected to it—is justified except in extreme cases and whether it is altogether devoid of danger. Further reports may yet disprove the harmless nature of this procedure. Furthermore, the few years since these operations started is too short a time to evaluate the end results. Since the human race got along so many centuries without this operation, and since we now have a sufficient collection of cases for the purpose of an adequate study of end results, I personally believe that it behooves the average surgeon to await the final decision of whether this is a passing style or a permanent fixture in surgery. Let us cease firing for two to five years and evaluate results.

Those cases giving the definite signs and symptoms of a cord lesion simulating a cord tumor still must be operated upon just as

they have been in the past. It is impossible to believe that the number of such positive cases has suddenly increased to the point of warranting such widespread laminectomies. It seems a justifiable conclusion to believe that many of these low back pains and sciaticas would yield to less drastic treatment just as they have in the past. Love states: "It is as antiquated to make a diagnosis of sciatica today as to diagnose headache." Nevertheless, I dare say there is more than one surgeon in this audience who, like myself, has had more than one attack of sciatica, who still enjoys and plays a fairly good game of golf. Intractable sciatica not yielding to adequate prolonged simpler treatment may well be due to a nucleus herniation or a cord tumor and may require more drastic treatment. There will always be inexplicable attacks of low back pain and sciatica just as there are unexplainable headaches. Certainly no one would advocate subjecting every headache to a ventriculogram or encephalogram or an exploratory decompression because of a possible brain tumor.

The author is convinced that in a great many roentgenological examinations, depressions in the intervertebral surfaces of vertebral bodies and other intervertebral disc anomalies suggesting derangement of the nucleus pulposus can be demonstrated. Many of these are found coincidentally in patients without the least sign or symptom of back pathology. Such anomalies in patients with low back pain without exceedingly definite neurological signs do not warrant the injection of lipiodol to prove or disprove the presence of a ruptured nucleus pulposus. He is convinced that certain great authorities who have concentrated on this subject definitely have proved the presence of this pathological condition as the cause of the back symptoms and have relieved it by operative procedure. However, the majority of conservative authorities agree that a fairly small percentage of the cases are sufficiently serious to warrant operative procedure. He is convinced that the men who have done the most work on this problem never intended that minor derangements should be an excuse for operation; neither did they intend for the nucleus pulposus to become a medicolegal football. Alleged injuries to the nucleus pulposus, with subsequent permanent disability, bid fair to become more popular than the old "railroad spine," once the favorite with personal injury lawyers and expert witnesses. Therefore, when one is dealing with an injury of the back, with medicolegal or compensation possibilities, he must think twice before injecting lipiodol. The presence of this foreign material at the base of the

spine, demonstrable by x-ray, may furnish the claim for the alleged continued back pain, a claim most difficult to refute.

Finally, all congenital and hereditary conditions responsible for back pain are not inherent in the spine itself.

The asthenic individuals are the best examples of a hereditary group, prone to have back ache. We are all familiar with this group, referred to by the older clinicians as the Stiller type—the tall, thin patient with a long trunk, flat chest, an acute rather than an oblique epigastric angle and the sunken upper and protruding lower abdomen. None of the previous descriptions of this individual mention the *flat back*, the complete loss of the normal lumbar curve which, occasionally in the young, but almost always in older individuals, is just as characteristic as the ever present acute epigastric angle. Even before the physical examination is made, one can predict that the liver is palpable, that the kidneys are movable and often floating and can verify his suspicion of a dropped stomach by x-ray. However, such an x-ray should be condemned, because when made and the patient is told that he or she has a “fallen stomach” it only serves to aggravate the symptoms and the mental depression.

In outlining the acute intercostal angle with the finger nail or a pencil, the typical tache cerebrale, or red streak, is left on the skin, thus suggesting vasomotor changes as characteristic of such patients.

We are all likewise familiar with the tachycardia and the heart complaints of many of these individuals; the dyspeptic complaints of others and other innumerable fears of grave intra-abdominal disease, especially malignancy. My favorite question put either to the patient or to a close relative if one is present is: “Is this patient one of the worriers of the world?” Invariably the relative answers, “yes,” although the patient usually denies it. Even in taking the history, this element of worry is quite apparent.

In considering the diagnosis of low back pain, and especially in the differential diagnosis from alleged injury, the author wishes to stress his four characteristic cardinal conditions inherent in these patients, namely, (1) the faulty posture; (2) the flat back; (3) the spastic colon, palpable in the majority, but suggested always by the history of flatulence, constipation or intermittent diarrhea, especially after some emotional upset; and (4) the great tendency to worry about and exaggerate their symptoms.

The above cardiac, dyspeptic and neurotic tendencies of these patients are common knowledge, but too little attention has been

paid to the asthenic group with back complaints, especially low back pain, often accompanied with sciatica.

Just recently this group is being approached from another angle. Read the recent descriptions in the literature of the disease called "fibrocystis," and see how many of these authors group the typical neurasthenic type, the effort syndrome type, the easily fatigued individual, the highly tensed spastic gut executive or society lady, as the ones most prone to fibrocystis. Not all of these are of the asthenic build but the symptoms so characteristic of the asthenic are found in the majority. Space will not permit further consideration of fibrocystis, but it is definitely a disease entity that must be considered in the differential diagnosis of many alleged minor injuries to the back with persistent symptoms.

Flat Back. A patient from another city who had fallen at work and ascribed his low back pain to the injury was referred to me after several weeks. Absolutely no other cause but the flat back and the asthenic characteristics could be found to explain his condition. Physical therapy and exercises to redevelop the lumbar curve were prescribed. He was making fairly good progress, when a relative persuaded him to go to a clinic. There the orthopedist told him that they did not take any stock in Mock's flat back theory. No diagnosis was made but he was fitted with a back brace. He returned home but the condition grew worse, especially as his compensation had been cut off. He became discouraged with the back brace. After a lapse of three months he returned to me. A thorough examination, x-rays and all laboratory tests were repeated with negative results. Two hours were then spent in explaining to this patient the hereditary factors in his physical and emotional make up. Fortunately, he recalled that his father had exactly the same build and was troubled with backache. I persuaded him that any effects of the minor injury had long disappeared and that he could carry out his exercises for re-establishing a better lumbar curve and could regain his emotional balance just as well while working as while loafing. The company agreed to pay him compensation to this date. He returned to work, and for over a year there has been no complaint from his back. You may say that this was a "compensation neurosis." True, these individuals are prone to develop neuroses and the majority of their complaints are on a nervous basis. In prescribing treatment for such individuals and especially inadequate physical therapy and back braces, one is liable to doom them to a permanent disability. In many of them, however, the low back pain and the sciatica is so acute that

there must be an etiological factor other than neurosis. In my opinion, that etiological factor is the *flat back* with its accompanying abnormal ligamentous pulls and strains, the muscular imbalances that supervene, the faulty postures assumed to ease the pain, and finally, the contracted aponeuroses and tensor fascia lata which, in time, may become a persistent factor in the chronicity of the condition. It is worthy of emphasis that the individual with flat back and with the other three cardinal characteristics mentioned above has a chronic weak back, prone to pain and discomfort on the slightest unusual strain or stress. The tendency to worry over slight symptoms aggravates the condition into a terrible calamity. The fair wear and tear of our daily existence develops certain fatiguing influences which manifest themselves in some way in the majority of us. It is safe to say that 80 per cent of the asthenic individuals who develop low back pain are in the age group between thirty and forty years. This has been a common observation on the part of myself and associates. It is my opinion that the above mentioned fatiguing influences reach their height in these individuals in this decade. Comparable to this are the neurocirculatory changes and the condition called "effort syndrome," most frequently seen between twenty and thirty years of age.

Before leaving disease conditions which may cause low back pain and which may simulate or be coincidental with injury, reference must be made again to persistent fibrocytic nodes as well as to painful subfascial lipomas. It has been pointed out by certain authorities that the asthenic type is more prone to low grade infection which probably accounts for the greater prevalence of spondylitis in this group. Likewise, many of the investigators of fibrocytis have stressed the prevalence of the condition in the asthenic individual or in those having a fatigue background. These two facts are enlightening from the etiological standpoint. Certainly the pathological studies of certain of these fibrocytic nodes which have been removed strongly suggest an infectious nature.

Painful subfascial lipomas, especially in the lumbosacral region, are not at all uncommon and are frequently mistaken for these fibrocytic nodes. We have no reason to believe that these lipomas are the result of trauma. In case of back injury with medicolegal possibilities, one must not be too quick to jump to the conclusion that persistent nodes, whether fibrocytic or lipomatous, are the cause of the alleged pain or are related in any way to the injury, and therefore warrant operative removal to cure an alleged injury. Like lipiodol injections,

the presence of an operative scar is visible proof to the laity of some preexisting serious condition, and the patient's alleged continued pain and disability are, therefore, very difficult to refute.

X-ray. The x-ray is invaluable in the diagnosis of back injuries and yet many *diagnostic pitfalls* exist if too much dependence is placed upon the presence or absence of x-ray findings. It is too often neglected in cases resulting from rather minor accidents, or is not resorted to until weeks or months later. The late x-ray may show osteoarthritic changes or even an old compression fracture, and because of the failure to take an immediate x-ray, one is unable to say definitely that this or that condition was pre-existent and without relationship to the alleged injury. The following roentgenological diagnostic pitfalls are extremely common:

1. The chief pitfall is the tendency to accept as final the statement that the x-ray of the spine is negative. We seem to forget that the x-ray will not show the ligaments, muscles, aponeuroses and other soft parts, and, therefore, when bone pathology is absent, we overlook the possibility inherent in the soft parts for both injury and disease. Furthermore, infectious conditions of the spine or early metastasis in the vertebrae often do not show in the first or even in the second x-ray.

11. The next commonest pitfall is to accept as final and conclusive evidence of the cause of the low back pain the x-ray findings of arthritis or of a nucleus pulposus derangement or of an acute angulation between the fifth lumbar and the sacrum, or other acquired or congenital anomalies. I have at least half a dozen examples of slight to marked spondylolisthesis, giving no signs or symptoms of low back pain and found inadvertently while examining for other conditions.

CASE REPORTS

CASE 1. L. M., sixty years of age, ran for a moving train. A red-cap seeking to intercept him was responsible for his fall on the platform. He sued the railroad for \$50,000. He was taken to one of our best hospitals, and an excellent surgeon diagnosed, following an x-ray, compression fracture of the first lumbar vertebra. I examined this patient with the attending surgeon four months later. The patient was confined to bed and was wearing a back brace. There were very acute signs of low back pain. The prostate was enlarged, but not abnormally so for a man of sixty. The remainder of the examination was negative. Examination of the original x-rays, which were the only ones that had been made, showed slight compression of the three lower dorsal and the two upper lumbar vertebrae with a more marked

narrowing of the first lumbar. The intervertebral spaces were narrowed and there was marked evidence of calcification of the anterior ligament and spur formations typical of an osteoarthritis. The attending surgeon insisted that the changes in the first lumbar were due to a compression fracture. The roentgenologist firmly believed that the narrowing of this, as well as of the other vertebrae, was more indicative of an osteoarthritis. This was likewise my opinion. Re-x-raying of the spine was suggested but was not done. The patient, wearing his back brace, left the hospital a few days later. Three months later the patient committed suicide. The autopsy revealed carcinoma of the prostate with metastasis to the spine. Additional later x-rays would have revealed the condition. I am told that the suit has been dropped.

CASE II. M. C., a young lady, twenty-four years old, was struck by a bus. Her injuries were minor and she was confined to the hospital only two days. The x-ray was considered negative. Later I examined this patient with an orthopedic surgeon who claimed she had a herniation of the nucleus pulposus. Her symptoms were exaggerated but practically no signs were present. His diagnosis was based upon a concavity in the superior surface of the body of the fourth lumbar vertebra. I showed him the x-ray of a nurse which showed an identical concavity, and yet there were absolutely no back or extremity complaints. He insisted that in spite of the absence of complaints this nurse had a herniation and that some trauma had occurred to account for it. This surgeon has become one of the outstanding exponents of trauma as the cause of all nucleus pulposus derangements and is a frequent witness to this effect. For every such case of alleged herniation due to trauma, I can show a similar x-ray finding of a concavity in a vertebra, even in young adults who have no sign or symptom of disability from the condition.

III. Why any surgeon or roentgenologist in this day of enlightenment should be content with only an anteroposterior view of the spine is inexplicable. Both lateral and oblique views are far more important for diagnosis.

CASE III. A. R., injured in an automobile accident in Michigan, was taken to a hospital and an x-ray of his back was made. It was reported negative for fracture. A contused back was diagnosed. Treatment consisted of rest in bed for two weeks. He returned to his home in Chicago and, because of continued pain, received osteopathic treatment for two weeks. He then secured a lawyer and started suit. The lawyer referred him to a doctor who secured x-rays of his back and, in the lateral view, discovered a compression fracture of the first lumbar vertebra. At the end of ten weeks the insurance company involved referred the patient to me, with the consent of his lawyer, for examination. I found the evidence of the old compression fracture in the first lumbar vertebra. Anxious to compare this with the original film made directly after the injury, I wrote to the doctor

in Michigan for his films. They were sent, and to my surprise, included only an anteroposterior view, which failed to show the fracture. Failure to take a lateral view was responsible for this very good physician's failure to diagnose and adequately treat a compression fracture of the spine. This is a very common mistake.

iv. It is far wiser to x-ray the entire spine in the presence of an alleged injury than to fail to x-ray a sufficient expanse of the regional spine necessary for the diagnosis of a recent or old condition.

CASE IV. W. B., a locomotive fireman, jumped from his engine when the boiler burst. He suffered first degree burns about the arms and legs. The engineer was knocked to the floor of the cab, sustaining a fractured leg and severe burns. The fireman pulled the engineer out of the cab, and later was able to walk to the ambulance that brought both of them to the hospital. The engineer was hospitalized for weeks and finally secured an excellent recovery without permanent disability. He settled his claim for a nominal sum. The fireman's burns were rather insignificant. The second day he complained of low back pain, indicating the site of pain as opposite the fourth lumbar vertebra. An x-ray, anterosuperior, lateral and oblique, was made of the lumbar spine. It was negative for any bony pathology other than a slight arthrosis, due to fair wear and tear. He was discharged at the end of two weeks. He refused to go to work because of an alleged low back pain. His variable points of pain, his exaggerated walk and the marked exaggeration of symptoms caused me to believe that this man was suffering from a "compensation neurosis." At the end of six months he secured a lawyer and filed suit for \$50,000. With the lawyer's consent he was returned to me for a check-up examination. I learned that he had been to two other doctors, chosen by his attorney, both of whom had likewise x-rayed only the lumbar spine. One of these called the arthritic condition in the fourth lumbar vertebra, a fracture, while the other said that it was due to a deranged nucleus pulposus. My physical examination revealed a marked increase in the exaggerated signs and symptoms as compared with my last examination, four months previously. He was now wearing a back brace. At this time I took an x-ray of the *entire spine*. This revealed an old compression fracture of the tenth dorsal vertebra, so definite that no one could overlook it or ascribe it to any other condition. It had all the earmarks of being a very old compression fracture, but neither the roentgenologist nor I could swear that it was older than six months. I am positive this was an old pre-existent fracture. The patient gave a history of an old back injury, but for some unknown reason was evidently confused as to its location. My failure to have made an x-ray covering a sufficient expanse of the vertebrae when he first came under my care was extremely embarrassing, and my chagrin was not assuaged by the fact that two other surgeons employed by the lawyer had made the same mistake.

v. Given a sudden low back pain, whether ascribed to trauma or otherwise, and the immediate x-ray is negative, it is rather common practice to diagnose the condition as sacroiliac sprain or to call it lumbago or sciatica. Frequently, a definite diagnosis can not be made. But in the presence of persistent back pain, it is simply courting trouble to rest on our oars with the original diagnosis, to be content to have the patient wear a sacroiliac belt, and neglect further observation and especially further x-rays. Here is an exceedingly important x-ray rule: *With the original x-ray negative but with the back signs and symptoms persisting, without a conclusive demonstrable cause, x-ray that spine at frequent intervals.* Too often the compression fracture will not show in the first film, but with movement and weight-bearing, the compression gradually develops, and the later film reveals the true condition. In the case of persistent trouble, the second, third or even the fourth film may be the only means of diagnosing the metastatic tumor which all along has been the cause of the back pain, rather than some minor injury which was coincidental.

CASE V. Doctor T., age fifty-two, had his chair collapse while attending a medical meeting. As he fell to the floor the back of the chair struck him in the middorsal region. A colleague examined the back and advised immediate hospitalization. The next morning the spine was x-rayed following which the doctor patient was informed that there was no evidence of fracture or dislocation in any of the vertebrae and that after a few days' rest he would be all right again. No further examination was made and neither were additional x-ray films taken yet the pain in the back persisted. He required morphine for four or five days to relieve the pain. At the end of the week the patient called an excellent internist who examined him thoroughly and also examined the x-rays. He pointed out an osteoporotic condition of the bones which had been noted previously by the roentgenologist but he could see no evidence of fracture. The doctor patient began to sense that he was considered a "neuro," and thought that possibly he was. He left the hospital at the end of fifteen days, and the following day went to his office in a taxicab. After a few hours in his office he collapsed. There was excruciating pain and marked dyspnea. He was taken home and the internist again called. The latter stated that his examination revealed a spasm in the muscles of the back and the chest muscles on the least effort at deep breathing. The internist again visited the hospital and examined the original x-rays but again could find no sign of injury to the vertebrae. A month later the internist asked the author to see this doctor, stating that while he was a marked "neuro" yet he might have some injury to the back. Examination at this time showed a definite knuckle

deformity over the eighth dorsal vertebra. He was taken to the hospital and x-rayed. Examination of these films showed in both views a very marked compression fracture of the eighth dorsal vertebra. The original x-rays were secured and examined for comparison and all who viewed them agreed that they failed to show this fracture.

CASE VI. Mrs. B., age forty, married, sustained a fall of little consequence in her home in March, 1929. Approximately two weeks later she complained of pain in her lower back. A good surgeon, a close friend of the family, was consulted. An x-ray examination was made which was negative for bone pathology. Because of the history of falling and because the pain and tenderness were located near the left sacroiliac region, a diagnosis of sacroiliac sprain was made, and the patient was treated with heat, massage and strapping. The pain persisted and subsequently a sacroiliac belt was prescribed and worn. After five months of treatment without relief, the surgeon made another x-ray examination. This film showed a marked metastatic carcinoma of the left ilium near the sacroiliac joint. The author visited this patient with the surgeon. Our examination at this time revealed a very small lump in the breast, most probably the source of the primary growth. It was the author's sad duty to explain to the husband the incurable condition, and to endeavor to make him understand why it showed in the second x-ray, while not visible in the first. Of course, the condition could have been discovered earlier by the rule laid down above.

VI. Failure to take an x-ray following an alleged injury, chiefly because the patient is feeling better when seen by the doctor, or the physical findings do not seem to warrant an x-ray or even to save expense for the patient or some insurance company or corporation, is one of the commonest pitfalls in the diagnosis of low back pain.

CASE VII. Mr. B., age sixty, an engineer, fell from his engine and struck his back across a rail. He was carried to his home and a doctor called. The examination was negative but the doctor suggested that if the patient was still in pain the next morning he would take him to the hospital for an x-ray. However, the patient was better and no x-ray was taken then or at a later date. After a week the patient got out of bed and limped around the house and yard but always complained of pain in his spine, especially on arising from the bed or a chair. He was referred to the author for examination after six months, with the statement that the old man was making too much out of his case and was endeavoring to get a pension. Whether an immediate x-ray would have shown the condition is problematical, but the roentgenological examination made at this time revealed a slight fracture of the first lumbar vertebra, and a definite compression of the third.

DIFFERENTIAL DIAGNOSIS

When the trauma is of such magnitude as to be quite obvious, and especially if the x-ray unqualifiedly proves the presence of injury, the problem of diagnosis is simplified. Even here, however, a thorough search for remote, less obvious injuries is essential. Failure to recognize this may doom the individual to a permanent disability in another part of the body, due to neglect of treatment. Likewise, a search must be made for the coincidental disease which may influence the management and prognosis of the case.

In the case of sudden low back pain, in which the question of injury is often problematical or an after-thought, the surgeon must become a veritable detective, for many are the physical, mental and compensation problems that coexist and may be responsible. Every logical clew must be sought and thoroughly investigated before the guilty factor or factors of low back pain can be finally indicated and honestly attacked. Thus, in searching for the cause of low back pain, *do not be content with x-ray and physical examination of the back alone*, whether the patient presents himself as an injury case or as one who has developed the condition without history of injury. The wise surgeon will search the entire body, and will utilize all necessary laboratory tests, ruling out possible conditions which may be of equal or greater etiological importance or which may influence the course of treatment and the patient's ultimate recovery.

While pain in the right lower quadrant suggests appendicitis, or pain in the right upper quadrant suggests gallstones, yet pain in the back must suggest a multitude of conditions. It may be the first symptom of a general infection, for example, the "flu" or smallpox; or the first symptom of a disease of the cerebrospinal system, as poliomyelitis, or the first evidence of a *genitourinary affliction*, for example, a stone in the kidney.

Gynecological conditions, especially fibroids and ovarian cysts, often give the first evidence of their presence by backache. For weeks this may be the only manifestation of an acute pelvic infection. Fortunately, the displaced uterus, when operated upon because of low back pain, has failed so often to relieve the situation that it is seldom attacked today as a causative agent. Uterine suspension is going out of style.

Primary carcinomas anywhere, but especially in the breast or prostate, very frequently attack the spine with their metastatic growths. The same is true of the obscure, often very difficult to

discover, bronchiogenic carcinoma. Hypernephromas may likewise give their first evidence by their metastatic appearance in bone. These secondary growths may be so infinitesimal that for weeks and even months they fail to give either physical findings or x-ray manifestations of their presence. We have already considered the diagnostic pitfall of failure to re-x-ray the back in the case of Mrs. M., with the small primary growth in her breast. Failure to make a complete physical examination including the rectal examination, combined with the later follow-up x-ray examination was responsible for one excellent physician failing to make a diagnosis of metastatic carcinoma of the prostate in the case of alleged injury, as exemplified by the following case report:

CASE VIII. Mr. T., sixty-three years old, a teamster, slipped on the ice while working for the village of R. In falling he struck a wagon wheel. He completed his day's work but the next day had pain in his back, and, therefore, went to the village physician. An x-ray examination was made but was negative for bone pathology. His back was strapped. The pain persisted but he was able to work on and off for a few weeks and then was forced to quit. The original x-ray showed marked osteoarthritis present, and the village physician believed that the original injury was not sufficiently serious to warrant the village assuming responsibility for this pre-existent condition. Furthermore, he felt that the old man was unduly exaggerating his complaints of pain. At the end of two months following this alleged accident he was referred to me for examination. The patient was definitely suffering back pain. There was marked limitation of motion, probably due to osteoarthritis. The examination of the back was negative, except for a definite constant point of tenderness in the region of the fourth lumbar vertebra. The rectal examination revealed an enlarged prostate that was undoubtedly malignant. An x-ray examination showed a destructive process in the body of the fourth lumbar vertebra, which was diagnosed by Dr. Hollis Potter as a metastatic carcinoma. The source of this growth was undoubtedly the prostate.

Bone sarcomas may attack the lower spine or the pelvis primarily or sarcoma in other regions of the body may form metastasis to the spine. Any one of these may give symptoms of low back pain for weeks before the sarcomatous lesion is demonstrable by x-ray.

CASE IX. A close friend of mine, a noted orthopedic surgeon, recently treated the son of a doctor for a slight injury to his spine. The original x-rays were negative and the cause of the condition obscure. The spasm in the muscles, the contraction of the fascia lata and the list of the spine, with the acute lumbar lordosis, caused them to contemplate operative pro-

cedures. Fortunately, before anything was done, another x-ray was made which revealed an osteogenic sarcoma of the left ilium.

Grave responsibility rests upon the surgeon presented with such a case, for often he must meet the medicolegal problem of whether an alleged injury is responsible for the sarcoma or even other forms of malignancy. (See previous paper on "Trauma and Malignancy" by Mock and Ellis, *J. A. M. A.*, January 23, 1926.)

Gastrointestinal conditions, for example, gastric or duodenal ulcers or the subacute retrocecal appendix, as well as gallstones, may be the source of the low back pain. Frequently, on jumping out of bed or leaning over to lace the shoe, or after lifting some object in the home, the low back pain suddenly develops and the patient ascribes it to the trivial accident. When the acute low back pain from these intra-abdominal conditions starts following lifting or other strain, while the patient is at work, it is not only important but often difficult to differentiate between alleged injury and low back pain from disease.

CASE X. Mr. N., a railroad official, was riding on his own railroad when a slight wreck occurred. He sustained a severe jolting and jerking. That night he developed a severe pain in the region of his eight dorsal vertebra. The pain persisted and on a few occasions caused vomiting. The x-ray of the spine was negative. At the end of a week he had a severe gallstone colic and the pain in the back grew much worse. Visualization of the gallbladder revealed gallstones. In the interval between attacks, the back pain persisted. At the end of a month I operated upon this man for gallstones, with complete relief of pain in the back. We have all observed acute gallbladder attacks developing shortly after some similar accident. What the relationship is, is difficult to explain, but obviously the true cause is the presence of the gallstones, rather than the accident. However, all the expenses of this patient's surgical ordeal were borne by the railroad, because of some problematical connection between the accident and the gallbladder attacks.

The above conditions, as well as many other acquired and hereditary abnormalities that the body is heir to may refer pain to the back and especially the low back. Hardly a day passes that most of us do not sustain sudden jolts, twists or strains and even falls. If a low back pain develops coincidentally with such minor accidents, it is only human nature to ascribe the condition to the most obvious factor, viz., the accident.

Conversely, disease and even traumatic lesions in the spine may refer the major symptoms to remote parts of the body, while the

local symptom of back pain is negligible. In such instances, the true lesion in the spine may be easily overlooked. The best examples of these are: (1) The gastric crises of tabes or the referred pain and paresis in an extremity, the result of a cord tumor. (Pernicious anemia was found as the cause in one alleged back trauma.) (2) Osteoarthritis of the dorsal vertebrae may cause referred pain around the chest simulating angina. (3) The osteoarthritis of the lumbar vertebrae, with impingement on the nerve roots and referred pain down the sciatic nerve or at least into the gluteal region, while the back pain is negligible, is a typical example.

This reference of pain and other symptoms to parts of the body removed from the spine is occasionally observed in major injuries to the spine, thus giving rise to some of our most confusing diagnostic problems.

CASE XI. An old gentleman, almost eighty years old, accompanied his two daughters on an automobile trip to a nearby city. He rode in the back seat. While driving rather rapidly the daughter struck a bump which threw the old gentleman to the top of the car and then to the floor. He climbed back on the seat and said he was not hurt. However, by the time they reached their destination he was suffering severe pain in his bladder and had a complete suppression of urine. A genitourinary specialist, a close friend of the family they were visiting, was consulted. This specialist diagnosed hypertrophied prostate with acute retention, and immediately did a cystostomy as the first stage in a proposed prostatectomy. When the time came for the second stage operation, the old gentleman insisted on returning to Oklahoma City, his home town, for the operation. Here the genitourinary specialist consulted believed that the prostate was not sufficiently enlarged to account for the trouble. He mentioned the case at the doctors' luncheon table and incidentally referred to the above bump and fall. Our old friend, Sam Cunningham, suggested an x-ray of the spine before removing the prostate. This was done, and a compression fracture of the first lumbar vertebra was discovered. This was treated and the old gentleman made a good recovery and kept his prostate until his death, three years later.

Radiculitis, or inflammation of the spinal nerve roots, is frequently ascribed to trauma. The pain is often referred to the extremities. How one can truly ascribe the condition in a given case to trauma rather than to irritation from small osteoarthritic deposits in the vertebral margins or without first ruling out cerebrospinal syphilis or some of the causes of peripheral neuritis, such as diabetes, alcoholism or lead poisoning, is extremely difficult to conceive and

yet radiculitis from trauma is not an uncommon medicolegal claim. Injury is likewise frequently held responsible for other forms of neuritis, as well as for myositis, myofacitis and other conditions of the soft tissues which may be accompanied with low back pain.

DISABILITIES DUE TO FAULTY TREATMENT

It is extremely important to diagnose the back pathology or the condition elsewhere causing low back pain before instituting any drastic or prolonged course of treatment. Faulty diagnosis too often leads to faulty treatment with the danger of permanent damage to the patient or an extremely embarrassing position for the surgeon. Finally, the treatment adopted may often result in pathological changes which are responsible for the continued low back pain long after the original condition is healed.

We are all familiar with the painful inflammatory reaction which usually follows the forcible breaking up of a soft tissue ankylosis in the shoulder joint, elbow or knee joint, and the danger of causing more pronounced stiffness and even permanent ankylosis from such a procedure. Yet many an injured or diseased back, the result of the acute condition or of the prolonged treatment, has a similar soft tissue ankylosis of some of its joints. Forceful osteopathic treatments to such a spine often results in prolonged symptoms of low back pain and even permanent disability. Manipulative surgery, used more and more in back conditions by surgeons and physical therapists, may, and do, result in prolongation of back pain and permanent disabilities, a danger which can be prevented only by a clear understanding of the existing pathology.

In the treatment of compression fractures of the spine, the forceful reduction of the compressed vertebra, under a general anesthetic, is strongly advocated by many. When the patient is asleep and cannot resist, it is difficult for a surgeon to gauge the amount of force he is exerting in such manipulations. Jacks, slings and other mechanical means of immediately reducing the compression have been devised. The amount of force exerted through these various mechanisms is even more difficult to gauge. It is, therefore, conceivable that the continued painful back persisting for months following the healing of such fracture may be due to torn ligaments and other ankylosing influences in and about the given spinal joints.

The older method of treating compression fractures, viz., rest in bed with or without hyperextension for several weeks without any effort made to maintain soft tissue tone and joint function, and then

placing the patient in a plaster cast or a back brace which he wore for several months to a year often resulted in even greater prolongation of symptoms and frequently permanent disability. Just as in other joints of the body, the prolonged immobilization resulted in a certain amount of soft tissue ankylosis, with atrophy of disuse and weakness of the back muscles and contracture of the aponeuroses. Undue prolongation of low back pain with eventual recovery was the rule for the young and middle aged, while the old were frequently doomed to permanent disability. It was because of the above results that some surgeons began advocating a spinal fusion for compression fractures, stating that they obtained quicker results and fewer cases with permanent disability. Their premise was wrong for there was no rime or reason in the old prolonged treatment of compression fractures.

In my opinion, neither forceful reduction of the compression fracture under anesthesia, nor the fusion of the spine in the presence of such fractures, nor the prolonged immobilization in a back brace are seldom, if ever, indicated.

The author's treatment of compression fractures gradually evolved in the last ten years since he gave up the use of prolonged immobilization and especially the use of back braces, is based upon anatomical and physiological facts, viz.:

1. The multiple joints about each vertebra.
2. The capsule and adjacent ligaments about these joints, as well as the more distant ligaments of the spine which may be stiffened by prolonged immobilization.
3. The soft tissue changes, the result of atrophy and disuse, which may occur in the muscles and aponeuroses.
4. The need of hyperextension with the resulting muscle and ligamentous pull on the body of the vertebra to overcome the compression. By increasing this hyperextension daily and within the patient's tolerance, the reduction of the fracture can be obtained just as well and with far less danger than by forceful hyperextension under anesthesia, within a period of two weeks.
5. Early mobilization of the joints by allowing hyperextension exercises, and as soon as the hyperextension cast is applied, allowing the patient to walk, usually at the end of three weeks.
6. Maintaining muscle tone and strength and pliable aponeuroses by the daily use of heat and massage, facilitated by turning the patient onto his belly while still maintaining the hyperextension position, and later, after the hyperextension cast is applied, cutting

a large circle in the back of the cast for the purpose of continuing heat and massage.

7. The fractured vertebra is healed at the end of eight to ten weeks, depending upon the physical condition of the individual, and at this time removal of the cast. If the physical therapy and exercises have been carefully and properly performed daily, the patient will not feel the need for a back brace or other support. No patient of mine with a compression fracture has had a back brace within the last ten years.

In the author's opinion, the symptoms of prolonged low back pain, stiffness and weakness in the back, weakness in the lower extremities, and the characteristic short-step limp, are usually due to a faulty line of treatment rather than to the original compression fracture.

Physical therapy, unless used intelligently, may be far more responsible for the continued low back pain than is the original disease or injury. Given a trivial injury in a nervous individual who shows a tendency to exaggerate his condition, one can often rub in more disabling conditions in a week than he can rub out in a year. The use of diathermy, quartz and other kinds of lights, mechanical exercisers, vibrators, and similar apparatus, often serves more to impress the patient with the seriousness of the situation rather than to cure him. Common sense and intelligent hand work are the essential factors in physical therapy to the spine. Rarely is machine therapy indicated. The overly enthusiastic, talkative physical therapy technician, suggesting a curvature of the spine here, a spasm in the muscles there, or the presence of painful nodes, is a menace in any back case.

Operative procedures on the spine are definitely indicated in certain well defined but limited conditions. A correct diagnosis of these conditions is imperative. Operative procedures in a group of poorly selected patients too often result in prolonged or even permanent disability or is actually worthless and thereby discredits legitimate back surgery.

CASE XII. Dr. Vincent O'Connor, of Chicago, has loaned me a lantern slide, taken one month after the patient had been subjected to a double bone graft operation for a spondylolisthesis. The orthopedist jumped to the conclusion that the severe low back pain was due to the spondylolisthesis, evidently shown in his original x-ray. In Dr. O'Connor's film, taken a month later, the metastatic carcinoma, shown in the ilium and lower

spine, furnishes the true clew for the pain. The primary growth was in the prostate.

CONCLUSIONS

1. Low back pain, the result of major injuries to the spine, is not a difficult diagnostic problem usually.

2. When the low back pain follows a minor injury or the history of injury is obscure or often an after thought, every possible etiological factor must be sought for and weighed before ascribing the condition to trauma.

3. The fair wear and tear of every day life—"functional trauma," congenital and acquired conditions in the spine, hereditary tendencies and constitutional diseases in remote parts of the body may be responsible for the back pain rather than some alleged trauma. The roentgenological findings in spines with these congenital and acquired changes must be studied exceedingly carefully before ascribing such changes to trauma.

4. The too facile explanation of trauma as the cause of the pain or of these congenital and acquired changes may cause one to overlook the true cause, for example, a metastatic tumor or other constitutional factor, with the result that great injustice and even permanent damage may ensue.

5. The clinical and roentgenological pitfalls which exist in the diagnosis of low back pain and in the etiological factor of trauma are illustrated with twelve case reports.

OUR CHANGING IDEAS CONCERNING PROTRUSION OF INTERVERTEBRAL DISCS

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DURING the last decade there have occurred numerous and drastic changes in our conception of protrusion of intervertebral discs. At this time it does not seem amiss to point out a few of these changing ideas and to consider some questions which are still controversial.

The conception of the pathological nature of this interesting lesion was the first idea to undergo revision. Adson¹ (1925), Stookey²⁸ (1928), Bucy⁵ (1930) and others reported cases of spinal cord compression in which the tissue pressing upon the cord was thought to be neoplastic and to which the term "chondroma" was applied. In 1929, both Schmorl²⁴ and Andrae³ published studies on the spinal column, and since then it has become evident that instead of these lesions being neoplastic they are abnormal protrusions of part of the intervertebral disc. In the same year Dandy¹¹ reported two cases of protruded intervertebral discs and correctly stated that the "tumor" was cartilage detached from the disc.

There is still no complete harmony of opinion concerning the portion of the disc tissue which protrudes, and, therefore, no agreement on a name for the condition. The term, "rupture of the intervertebral disc," was at first used by Mixter and Barr.²² Later microscopic studies¹² of the disc tissue removed at operation led to the conclusion that posterior protrusions of intervertebral discs which caused symptoms were composed of all parts of the disc including the annulus and the nucleus with its occasional remnants of notochord. Therefore, the term, "protruded intervertebral disc," was considered proper. Others,²⁶ however, preferred the term, "herniated nucleus pulposus," in preference to "protruded intervertebral disc" because they believed that nerve-root compression practically always was due to a rupture of the annulus fibrosus with an extrusion of the nucleus pulposus through the defect.

Mixter²¹ accepted the term, "protruded intervertebral disc," in preference to "extrusion of the nucleus pulposus." In a recent communication Spurling and Grantham²⁷ maintained that the

annulus fibrosus must be ruptured or torn for symptoms to be produced; if there is no extrusion of the nucleus pulposus, one set of symptoms appears; and if there is an extrusion, another set of symptoms occurs. They, therefore, used the term, "rupture of the intervertebral disc," with or without herniation of the nucleus pulposus.

Saunders and Inman²³ agreed that two types of protrusion occur. In some cases they noted fissuring of the annulus surrounded by "brown degeneration" with herniation of the nucleus, in other cases collapse of the disc with protrusion of the annulus with or without herniation of the nucleus.

The 1934 report of Mixter and Barr²² served as a starting point for another change in our conception of protruded intervertebral discs. Prior to this article protrusion of the intervertebral disc was considered a rare cause of low back and sciatic pain, but after they focused attention on this lesion its presence has been recognized frequently and operation for its removal carried out commonly. Enthusiasm regarding protrusion of intervertebral discs was accelerated to the point that every patient who complained of backache or sciatic pain was looked on by the neurological surgeon with an acquisitive eye. That every patient with a pain in his back does not have a protruded intervertebral disc has been emphasized by Henderson¹⁶ who reported that during a three-year period orthopedic consultants in the Mayo Clinic saw 10,000 patients who complained of low back or sciatic pain. Of the 10,000 patients only 188 or 1.8 per cent were subjected to operation for removal of protruded intervertebral disc. Since January, 1937, 142 patients complaining of backache and sciatic pain have been referred to me because of possible protruded intervertebral disc yet after neurological studies were made only nineteen (13.4 per cent) were operated upon for removal of protruded intervertebral disc or hypertrophied ligamentum flavum. I believe the rôle of protruded intervertebral discs in the production of low back and sciatic pain is finding its proper place.

Formerly it was the opinion that protrusion of an intervertebral disc was nearly always a result of trauma to the spine. Barr, Hampton and Mixter⁴ in 1937 reported that a history of trauma to the lower back was obtained from 80 per cent of patients with proved rupture of an intervertebral disc. In a recent analysis¹⁹ of 500 consecutive cases in which operation was performed it was found that only 58 per cent of the patients gave a history of specific injury to the back. Apparently then, in the presence of suggestive symptoms

and signs, one is justified in suspecting a protruded disc even though no history of trauma to the back can be obtained.

Another point upon which opinion has changed since we first began to recognize the condition concerns the total protein content in the spinal fluid. It formerly was thought that a total protein content of more than 40 mg. per 100 cc. of spinal fluid was always present in patients who had protruded intervertebral disc. Later² it was announced that about 25 per cent of the spinal fluids from patients with protruded intervertebral disc had a total protein content of less than 40 mg. In 1939, Love¹⁸ stated that 34 per cent of the specimens of spinal fluid tested from 265 patients with protrusion of intervertebral discs had less than 40 mg. of total protein per 100 cc. of spinal fluid. Still later Love and Walsh¹⁹ reported a series of 500 cases in which 40 per cent of the patients had less than 40 mg. of total protein per 100 cc. of spinal fluid in the specimens submitted for analysis. They believed that the low values from the total protein in the more recent series were due to changed spinal puncture technic. Previously, the puncture had been done as low as possible whereas more recently the puncture was between the first and second or the second and third lumbar vertebrae, so that an air spinogram could be done at the same time. Therefore, the spinal fluid obtained in the more recent cases was at a greater distance from the protruded disc which was usually located at the fourth or fifth lumbar interspace. The idea that the total protein content of the spinal fluid was higher near the lesion than at some distance from the lesion led to the practice of keeping the first 3 cc. of fluid separate from the remaining 7 cc. when a low lumbar puncture was done. However, in a study of more than 200 consecutive cases in which lumbar puncture was performed, Eaton¹³ found that a comparison of the total protein content of the first 3 cc. of cerebrospinal fluid with that of the remaining 7 cc. of cerebrospinal fluid removed at lumbar puncture was of little or no value in detecting or excluding organic lesions such as protruded intervertebral disc in the region of the cauda equina.

The last few years have brought changes in our ideas of the roentgenological methods employed in diagnosing protrusion of intervertebral discs. To quote from a 1937 article,²⁰ "Unless a definite level of motor or sensory loss is determined on neurological examination, subarachnoid injections of radiopaque oil for fluoroscopic and roentgenologic examination of the spinal canal is essential to establish a diagnosis of an intraspinal lesion. . . . If such a study

is negative for an intraspinal lesion, laminectomy for the removal of a protruded intervertebral disk should not be considered, for, in experienced hands, the smallest of defects can be diagnosed and localized by this technique." Injection of iodized oil still remains the most popular and most certain method of definitely establishing the diagnosis of protrusion of an intervertebral disc. Camp⁶ stated that in a series of 210 cases in which the patients were subjected to operation, oil studies revealed the presence or absence of an intervertebral disc with an accuracy of 92.3 per cent. A figure closely approximating this was given by Hampton¹⁵ when he stated that a positive diagnosis of a posterior protrusion of an intervertebral disc was made by the use of oil in 133 cases and in all except nine the diagnosis proved to be correct at operation. Therefore, the accuracy of his diagnosis by oil myelography was 93 per cent. However, contrary to early opinion, we now know that posterior protrusion of the intervertebral disc can be present and yet not be visualized by oil. This occurs especially when there is congenital shortening of the cul-de-sac or when the protrusion lies too far laterally to indent the sac.

Because lipiodal is not readily absorbed from the spinal canal other contrast media have been sought. Air and oxygen have many enthusiastic supporters.^{5,9} There is no doubt that the use of air or oxygen is a valuable adjunct in our diagnostic armamentarium, but the consensus of opinion is that by its use a positive diagnosis of ruptured intervertebral disc can be made in only about 50 per cent of cases. The logical conclusion seems to be that if a contrast medium is necessary for the diagnosis, it is well to try air or oxygen; and if this does not lead to a definite conclusion, oil can later be employed.

As cases of protrusion of an intervertebral disc have been studied, and more information regarding the symptoms and signs presented by these patients have accumulated, greater emphasis has been placed on the neurological findings to determine the presence and the level of the lesion. Localization of the lesion is aided by the fact that in the vast majority of instances, the protrusion is in the lumbar area, particularly in one of the last two interspaces. Spurling and Grantham²⁷ stated that 99 per cent of ruptured intervertebral discs in their series occurred at the fourth and fifth lumbar interspaces. In an analysis of 500 patients Love and Walsh¹⁹ found that 96 per cent had protrusions in the lumbar region and only a relative few occurred above the fourth lumbar interspace. Spurling and Grantham²⁷ believed that in fully 50 per cent

of the cases of protruded intervertebral disc, not only could the diagnosis be made, but also the level could be accurately predicted by symptoms and signs alone. They reported that if there is local tenderness of the third lumbar spine associated with hypesthesia and paresthesia in the fourth and fifth lumbar dermatomes, and a reduction or absence of the knee-jerk with the ankle-jerk unchanged, a protrusion is apt to be in the third lumbar interspace. If the localized tenderness is at the level of the fourth lamina with hypesthesia and paresthesia in the fifth lumbar and first sacral dermatomes, and ankle-jerks and knee-jerks uninvolved, the protrusion is in the fourth lumbar interspace. Likewise, if there is local tenderness to pressure over the fifth lumbar vertebra with hypesthesia involving the first and second sacral dermatomes, and a diminution or absence of the ankle-jerk, the protrusion is at the fifth lumbar interspace. It was emphasized that the accuracy and reliability of these neurological signs were proved by the fact that during eight months twenty-six consecutive herniations of the nucleus pulposus were successfully removed without the use of contrast media. While most other neurological surgeons have not relied as much upon neurological signs for the localization of the lesion, yet there is no doubt that some of the protrusions can be localized and removed without the use of lipiodol or air. Semmes²⁵ reported that he had operated upon sixteen patients from clinical evidence alone and in all sixteen cases the ruptured discs were found and removed. Craig¹⁰ operated upon twenty-seven patients, the diagnosis of protruded intervertebral disc having been made without the use of oil or air roentgenological studies.

One argument against the abandonment of a contrast medium is that a patient may have more than one protruded disc. Camp and Addington⁷ have reported that two or more protrusions were present in 12.9 per cent of cases in which the protrusion was diagnosed by lipiodol. It is very doubtful that multiple protrusions would be diagnosed by neurological signs alone and probably can be detected only by the use of a contrast medium.

As experience has been acquired, there has been a definite tendency to simplify operative procedures for protruded discs. At first the laminectomy was as extensive as that usually employed to remove a spinal cord tumor. Two or even three pairs of laminae were removed. Later laminectomy was shortened to sacrifice only one pair of laminae or hemilaminectomy was performed. Still later partial hemilaminectomy was employed, that is, removal of a part

of the lamina above the protrusion and a part of the lamina below the protrusion so that no one single neural arch was completely interrupted. Finally, there have been reports¹⁷ of cases in which the disc was removed by resecting a hypertrophied ligamentum flavum, thus obtaining room to remove the accompanying protruded intervertebral disc without the removal of any bone whatever.

Changes in the postoperative care have been associated with this simplification in the operative technic. For example, patients are kept in bed a much shorter length of time, and immediately following operation they are allowed greater freedom of motion. They may be taken to the lavatory within a few days after operation.

There is still some difference of opinion whether spinal fusion should be done at the time of removal of the protruded disc. The Mayo Clinic Group is quite definite in the opinion that spinal fusion is rarely indicated and recently stated¹⁹ that in only fifteen of more than 500 operations for protruded intervertebral disc was a fusion performed. Certainly there is an economic advantage in not performing a fusion since the period of hospitalization is tremendously increased when fusion is done. I believe that the decision as to whether fusion should be done or not depends largely upon circumstances in the individual case. If such conditions as spondylolisthesis or lumbosacral arthritis exist, a fusion is indicated. Also, if the patient must return to heavy labor, it seems logical that the more rigid his lower lumbar spine, the less chance of recurrence of pain. Thinning of the disc which frequently accompanies a protrusion of part of the disc, may, as Hadley¹⁴ pointed out, produce pain even though the protruded portion is removed. Thinning of the disc may produce pain by: (1) strain upon the ligamentous structures of the articulations, (2) disturbance in the relationship between the articular surfaces, (3) encroachment of the intervertebral foramen with fibrosis about the nerve-root bundles, and (4) bony impingement between the tip of the articular process and the peduncle above or the lamina below.

CONCLUSIONS

Within the last ten years protrusion of an intervertebral disc has become established as one of the causes of low back and sciatic pain. As experience has been acquired the diagnosis has become easier and more accurate, the surgical procedure simplified and the postoperative care less prolonged.

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DISCUSSIONS OF PAPERS BY DR. MOCK AND DR. RAAF

FRANCIS C. GRANT (Philadelphia, Pa.): I agree with Dr. Mock in his opinion about the cases of low back pain. Our experience has been that they require careful and detailed study prior to the institution of operative procedures. My impression is that too many operations are being performed for supposed intervertebral disc. Any type of low back pain is now being presumed to be due to this lesion. As Dr. Mock has so well emphasized, if an operation is performed and no disc is found, the final result may be very much worse following the surgical insult than the previous condition.

However, certain cases after close observation present definite indications of the presence of a disc. A history of injury with pain radiating segmentally down the leg followed by repeated attacks of "sciatica," disability of the lower part of the back with tenderness over the lumbar spines and flattening of the lumbar curve, a positive "straight leg raising" test with increase of pain on coughing or sneezing, significant changes in the Achilles or patellar reflexes and hypesthesia or paresthesias in the lumbar or sacral dermatomes all point clearly to a discrete lesion causing pressure on one or the other of the posterior roots emerging in the lumbar region.

Lipiodol has been widely used to confirm or refute the diagnosis of the presence of a disc. Justifiable objections have been raised to the indiscriminate use of this material, but I have not seen the serious results reported by some observers. We have used it whenever we were of the opinion that it was necessary. I know of a number of patients who have gone about unhampered for years with 4 to 5 cc. of lipiodol in their lumbar sac.

The position of the patient on the operating table is important. With the spine in extension the discs tend to recede into the intervertebral space. Slight flexion of the spine causes the maximum protrusion and makes the lesion much easier to identify.

I agree conclusively with Dr. Mock that prior to the identification of an intervertebral disc as a pathologic lesion, many patients with low back pain recovered under conservative treatment. In this connection Henderson's statement is important that only 2 per cent of the patients who

registered at the Mayo Clinic because of low back pain were found to have a disc. My plea in the handling of these cases is definitely for conservatism. Operation should not be advised until all other measures have failed and the history and clinical evidence indicate the presence of a disc very clearly. The results of indiscriminate surgery in cases of low back pain are too disastrous to warrant its use except on very well established grounds.

FRANK H. MAYFIELD (Cincinnati, Ohio): I have enjoyed Dr. Raaf's paper and find nothing in his presentation with which I could disagree.

Protruded intervertebral discs have occupied a considerable portion of my time and interest in recent years. During the past three years I have removed at operation forty-three discs from forty-one patients; thirty of them are entirely well; six feel that they are improved but will not work; the remainder are too recent to record.

We believe that we can diagnose the presence and level of most protruded discs on clinical findings alone and now rarely use lipiodol except in industrial cases in which preoperative verification is required by the Commission before authority for operation can be obtained.

Our experiences with gas spinalgrams has not been so good as reported by others, but the last two cases have been shown quite well by this method and so perhaps our ability to use this technic is improving.

The operation for removal of protruded discs in the lumbar areas has been so reduced in magnitude, as has been pointed out by Dr. Raaf, that the patients are allowed out of bed in seven to nine days and are discharged from the hospital in eleven days. They usually return to work in about six weeks. Among the earlier of our cases, two were fused by tibial bone grafts and neither has had a comfortable back since. A developmental or acquired anomaly of the spine may exist and require fusion, but this should be decided by an orthopedist beforehand, for certainly the operation as presently done creates no defect which in itself requires fusion.

Given a patient who presents the clinical data which Dr. Raaf has quoted from Spurling and his associates, and who has failed to recover under conservative treatment over a period of four to six weeks, I would operate upon him without the use of contrast media.

Cases with doubtful clinical data, of course, require the use of contrast media for verification, but even if the disc is found and removed, the oil cannot be completely removed and is not absorbed; and if the patient should not be entirely relieved, x-ray evidence of this residual oil makes impressive evidence before a jury. This medicolegal objection is about the only valid objection to the use of lipiodol in the spinal canal.

There is no reasonable objection to the use of air or other gas in the spinal canal, and we hope to improve our ability to use this method and apply it to doubtful cases.

JOSEPH E. J. KING (New York City): I have enjoyed hearing Dr. Raaf's paper. It is very practical, and full of common sense. I have also

enjoyed listening to Dr. Grant's discussion, and after hearing both, and seeing the lantern slides there is very little for me to say.

The main thing in the discussion of protruded or herniated intervertebral disc concerns itself with the practical consideration and not so much with theory. It is needless to say that every person with a backache or low back pain does not have a protruded disc. It would be equally as foolish to say that everyone who has a pain in the back should have a fusion of the spine performed.

After the diagnosis has been established the operation is rather simple. I think the most unusual fact about this subject is that this condition was not recognized as an entity and understood as it now is until a few years ago. Also, I think that in all discussions of this subject due credit should be given to Dr. William J. Mixter for his splendid paper read before the American Neurological Association several years ago in which he properly described the lesion.

I am not quite sure as to how one should establish the diagnosis. I agree with Dr. Grant that lipiodol should not be injected until one is almost certain of the diagnosis. It is possible that one might almost rely upon the physical signs and neurological examination without injection of lipiodol, but it goes without saying that the use of lipiodol makes the diagnosis more certain.

I have had some experience with the use of air, but I must say it has not helped me much more than ordinary plain x-ray films, therefore, I am not able to speak much in favor of injection of air as are some others.

So many writers state that if lipiodol is left in the subarachnoid space it does no harm. This may be true, but I am not yet convinced. I have had opportunities of operating upon several cases in which for some reason or other operation was delayed some time after the injection of lipiodol. In each of these cases I have found that some of the lipiodol injected in the canal had become beaded and imbedded in or alongside the component parts of the cauda equina. Some of these beads or inclusions of oil are about the size of a B.B. shot, and some about the size of a No. 7 bird shot, or even smaller. The little encysted globules of lipiodol were stuck on the side of the component parts of the cauda equina like nitrogen sticks on the roots of a pea vine. I also noticed that the blood vessels of the cauda equina were markedly injected and the roots seemed to be decidedly irritated.

It may be possible that this condition does no harm, but I doubt it. When lipiodol is used, it is my belief that the laminectomy should follow immediately, at which time almost all of the lipiodol can be removed. Personally, I favor the hemilaminectomy advocated by Dr. Alfred S. Taylor. I see no reason for bilateral or complete laminectomy unless the lesion is bilateral. The protrusion of the disc can readily be removed by hemilaminectomy, although it is somewhat more tedious, and I think that the back and spine are much stronger following hemilaminectomy than after complete laminectomy.

Dr. Raaf has covered the subject well and the only question I should like to ask him is this: Is he now able to decide to operate upon these patients who have the classical signs and symptoms without the use of lipiodol; i.e. does he think it is justifiable to do an exploratory laminectomy without the use of lipiodol?

PHILIP H. KREUSCHER (Chicago, Ill.): I am inclined to believe that a large percentage of cases of nucleus pulposus so-called are erroneously diagnosed. I have in mind one surgeon who made a diagnosis of 150 cases of nucleus pulposus seen by him within a year and a half. There is no question but that this condition is a definite surgical entity and gives certain very specific findings. But I fear that we have given the unscrupulous attorney something else upon which to base his claim for damage or injury which is not too clearly understood by the surgeons themselves and not at all by men in the legal profession.

I have seen a number of cases of bona fide nucleus pulposus rupture or protrusion. In two children at the County Hospital this occurred following a spinal puncture where the needle was driven far beyond the canal into the intervertebral space. The findings were typical and symptoms almost immediate. I saw one other case, a football player who had a compression fracture of the third lumbar vertebra, in which the impingement upon the cauda was also definite and immediate.

Not all cases operated upon, even in the very best clinics, get complete relief of symptoms.

I have reason to believe that in some instances a moderate protrusion may not give symptoms permanently since the cord and cauda so often accommodate themselves to the decreased space in the spinal canal. This is definitely seen in cases such as tuberculosis of the spine in which a spinal cord, at autopsy shown to be greatly flattened, had functioned perfectly.

Most of the cases which have come under my observation and which have been diagnosed as nucleus pulposus rupture or protrusion have been erroneously diagnosed as evidenced by the fact that when the settlement was made by the corporation or the insurance company the patient almost immediately recovered.

I think that before making a diagnosis of this lesion one must have a very definite clinical history and clinical findings. We are depending too much upon the x-ray and air injection. Lipiodol, in my opinion, should be injected into the spinal canal for diagnostic purposes only when the clinical findings coupled with the x-ray findings warrant such a procedure. Following this injection one must be prepared to proceed reasonably quickly with an operative procedure.

I make a plea for a delay in the very early diagnosis of and operation on these cases. One will find that often the spinal cord and cauda will accommodate themselves to an impingement if this actually exists.

EDGAR L. GILCREEST (San Francisco, California): I rise in behalf of the man with a backache who never had a protrusion of an intervertebral disc

or suffered from an arthritis of the spine. I think we ought to hear from that point of view.

I agree essentially with much that Dr. Mock has said. We are all familiar with the old story of the malingerer with the "railroad spine"—that is a sad chapter in medicine. But a slip in a facet causes a disabling backache and we have let the osteopath and the chiropractor cure literally thousands of people with this condition.

At the Southern Surgical Association, in Birmingham, two years ago, I reported 150 cases of backache. Seventy per cent of those patients, as I remember, were cured, most of them in a few weeks, by manipulation. It is not a difficult procedure and it cures the industrial patients as well as the private patients. I have doctors coming to me constantly with low backache which they developed while playing golf or lifting and they become ardent disciples as soon as they are relieved.

The old days of a man with low backache being given a bottle of liniment or a plaster have gone. When one has a slip in a facet, it is just as definite as can be. I have had many strong stevedores and other laborers come to my office, having had a slip occur several days before and during that time they had been at home in bed. They had been unable to lean over and tie their shoes. On examination, one found a contracture of the muscles on that side with trigger points, sometimes pain up in the shoulder, occasionally in the face and about the eye on that side. The patient is put on a table and after the application of heat the back is slowly manipulated with the result that 70 per cent will be relieved. The acute pain will be all gone and just residual soreness left. Many will go back to work in a few days.

This condition has not been generally recognized. I think it is sad that we have let the cultists take a very important part of medicine away from us and I am for returning them to the fold. No association should be more interested in this subject than this one.

HENRY C. MARBLE (Boston Mass.): I did not intend to say anything again this afternoon, but I believe that there is something very definite to be said on this subject. Much as I dislike to do so, I must disagree entirely with Dr. Mock. Are we not reasoning from the back forward?

I must confess more sympathy with the case of the man with a sore back. I think that the man with the sore back has usually a real pain in his back. Once upon a time I had occasion to study a series of a thousand consecutive backaches and less than 2 per cent of them had referred pain down the leg.

I think that the diagnosis of malingering, and other such diagnoses as that, should be thrown in the scrap heap. Now we have after all these years found a cause of a certain small number of backaches, or rather, referred pain down the back. Intervertebral disc is just as real a lesion as appendicitis; and just because doctors do not know enough to make the diagnosis, that does not mean that the man with referred pain down his back is a faker

or a malingerer, or any of those things described by words which I dislike very much.

Dr. Mixter, Dr. Barr and Dr. Hampton, have written extensively on this subject. There have been done in the Massachusetts General Hospital in the last ten years somewhere in the neighborhood of 125 cases for intra-vertebral disc. In one large Middle West clinic 350 were done in the year 1939 alone, so one would not exactly accuse Boston of being radical. In ten years we have accumulated about 125.

I have talked recently both with Dr. Mixter and Dr. Barr, and they agree with me that the diagnosis of intervertebral disc can be made in a high percentage of cases after a careful, thorough physical examination of the cases, by taking histories and doing physical examinations, by taking careful x-rays and a careful medical, orthopedic, surgical and neurological examination, and then a lumbar puncture may aid in finding out the amount of protein present. After this has been done, and *only* after this has been done, after the whole case has been carefully evaluated on the basis of its clinical symptoms, is the matter of whether or not a surgical operation is indicated, discussed or considered.

And, after it has been decided that in all probability a surgical operation is indicated and necessary, then, and only then, should lipiodol be injected.

The use of air, I believe, is of little value. Enough air cannot be put inside the dura to give an adequate column to fill up higher than the fourth lumbar vertebra, so it is practically useless. Enough lipiodol shall be given to fill the space, and in the hands of Dr. Hampton, as has been reported today, about 93 per cent positive diagnosis have been made; after the diagnosis is made, the operation can be done.

Of this group there have been approximately twenty-three so-called industrial cases. They are called industrial cases when the bill in the hospital has been paid by an insurance company; and if my recollection serves me right, seventeen of those twenty-three patients returned to their usual hard labor.

In my personal cases, although I do not do the operation, I have found intervertebral disc is a real, clinical entity, which probably represents less than one-tenth of 1 per cent of the backaches that come into a doctor's office.

Dr. Barr told me recently that of the patients who came to his office, about 20 per cent were ultimately found to have intervertebral discs; and when you consider that probably he got only a very small percentage of the patients with backaches who went to doctors, this is only a tiny part of the matter of low back pain.

CHARLES C. GREEN (Houston, Texas): It is with a certain amount of temerity that I rise to disagree with such an eminent surgeon as Dr. Marble. He has taken an extreme view of the problem and I must disagree

with him. I have had many a headache because of backaches from trauma, with only subjective symptoms.

There is no doubt in my mind that many backaches are the result of a misplaced disc and since we have learned to diagnose this lesion a great number of cases, formally thought to be the result of malingering instead of trauma will be relieved. But I have seen numbers of backaches and similar conditions go on without improvement in spite of all character of treatment only to clear up entirely after having a satisfactory claim adjustment.

I call to mind a supposed brachial plexus injury claimed to have been received by a Mexican employee of the railroad. He was in the hospital for twelve months under the care of capable doctors but he did not improve. At the end of twelve months he was dismissed and told we could give him no further treatment. Two or three days later the Mexican Consul called on me insisting that he be given his total and permanent disability insurance. I refused to allow it but told the Consul that if he would get this Mexican to submit to a simple test I could prove that my position was correct. He accepted my proposition and the Mexican was carefully anesthetized to a surgical degree of anesthesia. He was then allowed to recover from the anesthetic until his reflexes returned and then I saturated the cone with ether and put a wet towel over the mask in such a way as to cut off all air, the patient began to struggle for air and we held his unaffected arm and finally he reached up with the supposed paralyzed arm, pulled the mask from his face and held it up in the air until I told the Mexican Consul to take it.

This was proof enough so the Consul dropped his claim. But for months he continued to walk around Houston with a useless left arm and a spastic paralysis of the left leg. A day or so before I left Houston for this meeting I was at lunch at the Rice Hotel and this supposed paralyzed Mexican was my waiter and was carrying a heavy tray of dishes with his left arm. When he saw I recognized him, he told me he was well and asked if I thought the railroad would give him his job back. I told him "Hell, no."

This is a concrete example of where a corporation would have been done a grave injustice unless it had been so thoroughly demonstrated to the Mexican Consul that his man was faking, so we must be very careful to work out cases and determine which are real cases of pain and which are malingerers.

JOHN D. ELLIS (Chicago, Ill.): In discussion of these excellent and comprehensive papers there are so many interesting aspects to consider that one might easily go far afield and I shall emphasize only a few of the important points that have been made.

Systematic and general examination of the "industrial back" is our only means of avoiding such embarrassment, as is represented by Dr. Mock's lantern slide, showing a splendid low back fusion inadvertently performed upon a case of carcinoma of the prostate with metastases scattered in the spine and pelvis.

Repeated examination over a prolonged period is our only safeguard against overlooking a cord tumor or posterior herniation of a disc. When first seen, the patient's symptoms may be entirely subjective. An examination made later will show the objective finding of changes in reflexes, and skin sensation, loss of muscle tonus or wasting, etc.

The head of the surgical department of one of our universities recently told me he dreaded to give an opinion on a minor back injury case for fear of overlooking a cord tumor before definitive signs had developed. Every surgeon that treats so-called "industrial back" cases is likely to find himself becoming an internist. In this connection, the report of Dr. R. T. Johnstone, director of occupational diseases at the Golden State Hospital in Los Angeles, is interesting. He has recently had the opportunity of making a systematic study with unlimited laboratory investigation of 3,018 consecutive workmen, claiming compensable disability from back injuries. He denied compensation in 70 per cent of these, based on the finding of definite nontraumatic causes of the disability and concludes that from an internist's standpoint "industrial back" is not primarily an orthopedic problem but one for differential diagnosis.

Dr. Mock outlined osteoarthritis. There is a medicolegal point here to which we could all afford to give some thought. If we could distinguish in our terminology between degenerative joint diseases, not in themselves painful, by using the term "arthrosis," as all the continental medical literature does, and "arthritis," an inflammatory disease, discarding entirely the English term "osteoarthritis," we would be in a much better position to explain at a Compensation Board hearing our distinction between painful and nonpainful spinal conditions.

Both papers raise another question of medicolegal importance. How can we controvert a claim before the Compensation Board that the presence of lipiodol in the spinal canal may in itself be productive of disabling symptoms? To mention only a few recent reports in the literature, Drs. B. R. Young, M. Scott, and A. F. Lindholm could be cited to prove that the oil may have a permanent deleterious effect. It is difficult to get every globule of lipiodol out of the dural sac even at operation. However, if no lipiodol has been injected it is often unnecessary to open the dura in the removal of a posteriorly herniated disc.

Fortunately, in one case in which this oil was left in the spine after an examination which revealed no herniation, I was able to extract most of the oil by placing the patient in a sitting position and introducing a curved trocar, used in nasal surgery, into the sacral hiatus. The lipiodol is heavier than spinal fluid and by having the patient cough repeatedly most of the oil flowed out.

It strikes me that in industrial cases it is preferable to operate "on suspicion" than to leave any considerable radioopaque material in the canal.

The statistics bearing on the frequency of posterior disc prolapse are misleading. When a new clinical entity, such as this, is discovered, many

cases are soon reported in the literature. One clinic after another reports a series of cases operated upon, and the relative frequency of disc prolapse in proportion to the other back conditions seen in each clinic rises. This does not mean that the actual percentage of back injuries presenting disc pathology increases. It means only that the published lists of cases induce the medical profession in that particular vicinity to send into the clinic for operation more and more disc herniation cases.

In a way such medical literature is an advertisement, making an appeal for certain surgical work to be sent to the author and should be regarded as such. This is not said in disparagement of the excellent work of Camp, Love or Adson, but only to call attention to the fact that the apparently increasing percentage of back cases they see needing operation for posterior disc herniation is due to the fact that such pathology is diagnosed by the referring physician, and the patients are sent in because they need operation. Actually the condition is rare. The only way to judge its frequency is by study of a large series of autopsies on the spine, such as that of Schmorl, of Dresden, who routinely examined about 10,000 spines. Eighteen of these presented small and generally multiple posterior prolapses not large enough to displace the cord; two were traumatic, one from a stab wound and one associated with severe vertebral injury.

HARRY E. MOCK (closing): This discussion was centered chiefly around the nucleus pulposus. In the excellent movie shown here we have witnessed an example of the protrusion of this nucleus in a case in which operation certainly was indicated. This example bears out the statement in my paper that good conservative surgeons are finding definite protrusions of the disc, giving very definite neurological findings which require operative intervention.

I mention cord tumors because this condition represents a pathological entity which gives definite neurological signs and symptoms and yet the diagnosis is missed so frequently. Too many of these patients have been allowed to suffer for months and years before the true diagnosis was made and the condition relieved by the necessary operation. No one in the past, and few of us today, would advocate exploratory operations on patients with indefinite but persistent back pain and sciatica in order to ascertain whether or not they had a cord tumor. The profession has demanded that cord tumors be recognized by the presence of very definite neurological findings, and until these findings exist operation is not indicated.

I feel very strongly that the protrusion of the intervertebral disc into the canal should give definite neurological findings, comparable to the situation in cord tumors, before we subject these patients to operation.

In reality, Dr. Marble does not disagree with me one iota in my condemnation of nucleus pulposus operations. I agree with him that there are conditions in the spine that give such definite symptoms that good team work between the orthopedic surgeon and the neurological surgeon usually

can give relief. Not one word have I said condemning operations on these patients.

I must strongly condemn the growing tendency, prevalent all over the country, to diagnose nucleus pulposus derangements when patients with low back pain are found to have x-ray evidence of a slight concavity in the inferior or superior surfaces of one or more of the vertebral bodies. Too many of these patients are being told by their doctors that they have this new disease, herniation of the nucleus pulposus, or that this disease is strongly suspected. In lieu of calling such conditions a slipped sacroiliac joint and placing the patient in a back brace, too many of these doctors are referring them to this or that specialist or this or that clinic because of this suspected new disease. Too many doctors are saying, "I must take you to the hospital and inject lipiodol and then you will probably have to be operated upon." Most of the patients do not follow these directions but drift into other hands. But the damage has been done, the seed of phobia has been planted in their minds and it is almost impossible to get rid of the back pain as long as this fear of some obscure condition in the spine which may require operation exists.

One of the discussors said today that fusions of the spine were becoming altogether too popular but this popularity has been checked by this new operation. This is a confession of a change in surgical style that I do not want to see happen with this condition—a condition that is so extremely definite when it is present. But we are bound to have this operation condemned as a fad if we keep on diagnosing herniations, protrusions and other nucleus pulposus disturbances in the thousands of low back pains that are occurring every day the result of the same ordinary conditions that have caused low back pains throughout the centuries.

I beg that, before jumping to the conclusion that trauma is the cause of the low back pain and before advocating a radical operation upon the back, we investigate every case so thoroughly that the kidney stone, gallstone, fibroid, metastatic carcinoma or the numerous other conditions in other parts of the body that can cause low back pain will not be overlooked if present. It is just as faddish, just as detrimental to give short wave diathermy, lamp treatment or other forms of physical therapy to such a back when other conditions in other parts of the body are responsible for the trouble.

I deeply appreciate the very frank discussion of my paper.

JOHN RAAF (closing): The controversial point of whether lipiodol, if left in the spinal canal, can produce untoward effects is of considerable interest. For instance the Oregon State Industrial Accident Commission favors removal of the lipiodol even in those cases in which studies are negative. The reason for this is fear of litigation over its presence in the spinal canal rather than conviction of it actually producing symptoms.

I have removed lipiodol from several patients who were not operated upon for protruded disc. An x-ray should be taken to visualize the end of

the dural sac. With the patient in the sitting position a small burr hole can be placed in the sacrum and the tip end of the sac opened. If the patient is in this position the lipiodol can be removed practically in its entirety.

The importance of the patient's position on the table during the operation, which Dr. Grant has mentioned, was exemplified to me in a case in which the disc was exposed, but before it could be removed it disappeared. Hyperextension of the spine failed to make it reappear. When the spine was flexed, however, a clamp could be inserted into the disc and the portion which had formerly protruded was withdrawn.

Disks located at the fifth lumbar interspace are difficult for me to visualize with air and therefore I do not think air studies can be conclusive in these cases.

Dr. King asked whether I would operate for protruded disc without the use of lipiodol or air. As yet I have not operated upon any patients on the basis of neurological signs and symptoms alone. Just before leaving Portland I saw a patient for whom I advised conservative treatment. Should this patient eventually come to surgery, I would be willing to operate without the use of air or lipiodol because the symptoms and signs were typically those of protruded intervertebral disc.

A history of severe injury to the spine is not necessary for the diagnosis of protruded intervertebral disc. Naffziger and his associates have estimated that when a person lifts a fifty pound weight, 500 pounds of pressure are exerted on the lower lumbar discs. From this deduction one can assume that repeated strain upon these discs incident to every day work is enough to produce protrusion of a disc. Furthermore, I believe history of intermittent pain is more important in making the diagnosis than history of a single severe back injury.

Why does the patient have intermittent symptoms? One reason, as has been pointed out, is that the protruded portion of the disc may slip back into place, thus relieving the pressure on the nerve root. Another factor is that at intervals the disc may become edematous and enlarged.

I was glad to hear Dr. Marble state that Dr. Barr proved the diagnosis in only 20 per cent of the patients who came to his office with the presumptive diagnosis of protruded disc. This corresponds to my own experience in which only 13.47 per cent of those who were at first suspected of having protruded disc were operated upon.

I certainly do not believe it is advisable to defer operation until these patients have developed all the signs and symptoms of spinal cord tumor, for many patients with protruded disc never develop symptoms other than pain.

I wish to thank all those who took part in the discussion.

THE COMPATIBILITY FACTOR IN THE TRANSFUSION OF BLOOD*

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THE transfusion of freshly drawn blood is still attended by a mortality and morbidity which should be matters of serious concern to everyone engaged in this work. The exact incidence of these tragedies as they occur in the hands of thousands of practitioners who are transfusionists is unknown, because they fail to record and publish their results. Data concerning only a small fraction of the transfusions which are currently performed are available for study. These reports come for the most part from the better hospitals and clinics where the results are notably superior to those which are generally prevalent. The information even from these sources is often incomplete. Typical of these data are the following reports: Hesse and Filatov¹ in 1933 reported from Leningrad a mortality of 1.3 per cent among 750 transfusions. According to DeGowin² seven deaths occurred among 3,500 citrated blood transfusions performed at the University of Iowa Hospital from November, 1933 to July, 1937, an incidence of 0.2 per cent. In 1936, six reactions of incompatibility occurred in about 2,000 transfusions performed at Bellevue Hospital, New York, during the preceding six years, an incidence of 0.3 per cent.³ In the same year six deaths were reported from one British hospital during a period of only two and one-half years.⁴ Among 3,295 transfusions performed at the Mayo Clinic during 1938 the incidence of the definitely untoward and severe reactions amounted to 0.4 per cent.⁵

Probably quite typical of many observations is that of Dameshek⁶ who, in December 1938, wrote as follows: "Within the past year it has been my sad privilege to see in consultation at five different hospitals in and around Boston as many serious transfusion accidents. The first four were fatal; the fifth undoubtedly would have been had not the surgeon withdrawn the needle when the reaction occurred. . . . Since this is solely my own experience, it is certain

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that other such serious accidents have occurred in this and nearby communities, and that most of them have gone unreported."

In most instances in which freshly drawn blood is given the authors admit that these disasters are due to blood incompatibility. Occasionally, however, an attempt is made to prove the contrary but like Bordley⁷ in 1931 we have not found since that date a single case report with "complete and satisfying evidence to prove that the blood of the donor was compatible with that of the recipient."

Seldom are transfusion deaths and morbidity any longer due to technical errors of the transfusionist or to his employment of dangerous apparatus. The other possible or alleged causes of trouble such as allergy, tendency toward thermic reactions, susceptibility to shock and renal disease are rarely if ever proved to be the actual or even the probable disturbing factors when freshly drawn blood is given.

It is in the clinical laboratory instead of in the operating room or at the bedside that errors are committed which give rise to practically all of the present day transfusion mortality and morbidity. The prevalent technic of administering blood is highly satisfactory but the prevalent technic of examining it is quite unsatisfactory. Because of this, blood transfusion in most places has not yet been robbed of all dangers attending its use. This is particularly regrettable because reliable and practical laboratory tests have been known and given wide if not repeated publicity for nearly a quarter of a century. Thus Lindeman⁸ wrote as follows in 1916: "By careful, accurate and complete hemolysis and agglutinin tests, when the work is done skilfully, blood transfusion is robbed of all danger attending its use." He emphasized the importance of skilful laboratory work and described a technic for compatibility determination which he and others since have employed with the utmost satisfaction. Lindeman's contribution did not cause a general elimination of the evils which existed then in connection with this work and which have persisted in most places up to the present time. They are two, namely, unskilful laboratory work and the employment of tests which do not meet all the requirements for safety.

In many of our better hospitals and clinics, to say nothing of the less favored ones there is a deeply rooted custom of relegating the clinical laboratory work to individuals whose training and experience are not sufficient to enable them to perform skilfully and with safety all the tests which are assigned to them. Compatibility tests fall into a category of laboratory procedures which require a con-

siderable amount of time and experience under expert supervision for the development of satisfactory skill in their performance. These tests do not permit of unchecked errors without possible and probably grave consequences to the patient. Now it is a well known fact that interns as a class spend too little time in the clinical laboratory even when under expert guidance to become more than tyros in this work. Yet they alone are responsible for these vital tests in many places and as seniors on the laboratory service may furnish their juniors with the only instruction which they receive in compatibility tests. As already intimated the fault here lies with the briefness of the laboratory service and the inferior training and supervision given. These critical remarks are applicable also to technicians. We know, however, that the latter, as a class, with far less formal laboratory training in the basic sciences than the interns have, are capable of becoming satisfactorily proficient in this work after a period of several months of intensive training under a competent clinical pathologist who is indispensable for any safe and satisfactory plan.

A recent survey of blood transfusions in America conducted by questionnaire mailed to about 700 hospitals approved for internship under the authority of the Blood Transfusion Betterment Association of New York City, netted 350 replies which indicate, according to Levine and Katzin⁹ that in the selection of donors five depend upon blood grouping alone, thirty upon direct matching alone, of which only three include cross-matching and 310 employ both grouping and direct matching of the donor's cells with the recipient's serum.

Now all of these tests, as usually performed, are unsatisfactory for the detection of hemolysis. The fact is that they are employed almost universally for the detection only of red cell clumping with little if any regard for evidence of red cell destruction. The latter evidence as seen in these tests, such as increased transparency of the mixture and the shadow-like appearance of red cells is not sufficient for accurate and consistent recognition even by experienced individuals. It is unsafe, too, to assume the sufficiency of the agglutination reaction alone on the basis of the idea as expressed by Moss¹⁰ in 1910 that "iso-agglutination may occur independently of iso-hemolysis but iso-hemolysis is probably always preceded or accompanied by iso-agglutination." Contrary to this view there is evidence of the occurrence of hemolysis without preceding agglutination. However this may be, experience has proved the necessity for tests

for hemolysis which are more reliable than the ones under consideration here.

Detection of the hemolytic factor of incompatibility is of such vital importance because practically all transfusion deaths as they are now reported are characterized by massive hemolysis.

Blood grouping alone is quite unsatisfactory for several other well known reasons such as the proneness of the grouping sera to deteriorate in titer and to give rise to errors thereby, its failure to provide controls for the checking of errors and the conformation of the test to the erroneous assumption that there are only four blood groups when, as a matter of fact, there are subgroups for the detection of which more accurate tests than standard blood grouping are necessary and important.

Direct matching does not check the reaction between the cells of the recipient and the serum of the donor, a possible reaction *in vivo*, which can not be ignored with safety. Cross-matching obviates this fault but like direct matching it is a relatively crude test as it is described in most textbooks and as it is performed in most places. A drop of serum is mixed with a drop of red cell suspension. If the agglutinin titer is low and the concentration of red cells is high, no agglutination is likely to occur even in the presence of factors of incompatibility.

In view of these several serious shortcomings of the above tests it is highly desirable to discard them for safer ones such as that described by Lindeman, which has the incomparable advantage of being absolutely reliable and at the same time simple enough to be performed by any reasonably intelligent and properly trained technician. It automatically excludes errors resulting from the crudest kind of technical mistakes in blood grouping to the more confusing errors theoretically caused by minor differences within the blood groups. It thus conforms to all the known and unknown groups and subgroups of blood and reveals at one and the same time in a readily detectable manner incompatibilities of both iso-agglutination and isohemolysis.

This technic was introduced into the clinical laboratory of St. Luke's Hospital, Chicago, by Dr. Edwin Hirsh¹¹ in 1924 and into the clinical laboratory of Trinity Hospital, Minot, in 1932 by Dr. P. J. Breslich, who trained under Dr. Hirsch. This method of compatibility determination has resulted in the complete elimination in both hospitals of serious transfusion reactions in all cases in which it has been employed. The number of transfusions performed annually at

St. Luke's Hospital is approximately 600 and at Trinity Hospital 200; all told, therefore, about 9,000 blood transfusions have been given at St. Luke's Hospital and 1,600 at Trinity Hospital without the occurrence of a single disaster.

Lindeman's technic of hemolysis and agglutinin tests as employed at St. Luke's and Trinity Hospitals has been modified somewhat but not in any of its essential details. It reveals in test tubes all the noteworthy reactions of incompatibility which occur when saline suspensions of red cells are mixed with different dilutions of serum and are permitted to stand at room temperature for one and one-half hours. Cross-examinations are carried out in this fashion between the red cells and sera of both the patient and the recipient. Control reactions are run between red cells and saline solution alone, and between the red cells and serum of the same individual.

Preliminary typing or blood grouping is carried out routinely for the purpose only of selecting for the actual compatibility tests individuals of the same blood group as the patient. Only members of the same group are so tested. Since blood grouping in our hands is never relied upon for the actual selection of donors, an error in this regard causes the patient no trouble, where otherwise it might cost him his life.

It is necessary to determine compatibility before each transfusion when it is repeated regardless of whether the same or other donors are to be used because of the occasional occurrence following transfusion of incompatible factors which otherwise will not be discovered.

Blood in the amount of 10 cc. is withdrawn for the examination. It is divided and to 2 cc. are added oxalate crystals to prevent clotting. The serum from the remaining portion is recovered after separation from the clot. The oxalated blood is centrifuged and the cells removed. They are washed in physiological saline solution three times to rid them of serum. The final packed cell mass in the centrifuge tube is converted into a 5 per cent suspension by the addition of saline solution.

Ten test tubes are arranged in numerical order in a rack. (Fig. 1.) Into each of tubes 1, 2, 3, 4 and 5 is placed 0.1 cc. of a 5 per cent saline suspension of the donor's erythrocytes. To each of tubes 1, 2 and 3 is added the recipient's serum in the following amounts, respectively: 0.1, 0.2, and 0.4 cc. Four-tenths of a cubic centimeter of the donor's serum is added to tube 4. Into each of tubes 6, 7, 8, 9 and 10 is placed 0.1 cc. of a 5 per cent saline suspension of the

recipient's erythrocytes. To each of tubes 6, 7 and 8 is added the donor's serum in the following amounts, respectively: 0.1, 0.2 and 0.4 cc. Four-tenths of a cubic centimeter of the recipient's serum is

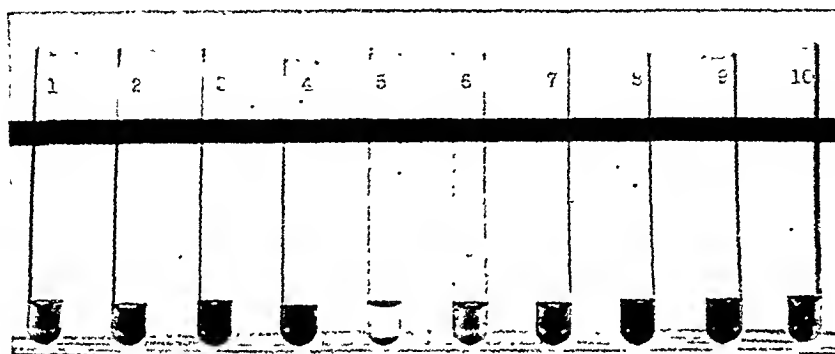


FIG. 1. Photograph of the rack of ten test tubes sometime after completion of the mixtures. Final reading for agglutination and hemolysis is made only after the expiration of one and one-half hours.

added to tube 9. Physiological saline solution is added to the 10 tubes in amounts sufficient to make the content of each equal to 1 cc. In tubes 1, 2, 3, 6, 7 and 8 occur the cross reactions between the serum of both the donor and the recipient in three different dilutions and their erythrocytes. In tubes 4, 5, 9 and 10 occur control reactions between serum and erythrocytes of the same origin in saline solution and the erythrocytes alone of both the donor and the recipient.

CHART I

Tubes No.	1	2	3	4	5	6	7	8	9	10
Donor's erythrocytes										
1-20 dilution.....	0.1	0.1	0.1	0.1	0.1					
Donor's serum.....				0.4		0.1	0.2	0.4		
Recipient's erythrocytes										
1-20 dilution.....						0.1	0.1	0.1	0.1	0.1
Recipient's serum.....	0.1	0.2	0.4						0.4	
Physiological saline solution	0.8	0.7	0.5	0.5	0.9	0.8	0.7	0.5	0.5	0.9

This chart shows the exact content of each of the ten tubes employed in the compatibility test.

After preparation, the tube mixtures are allowed to stand for one and one-half hours. Delayed reactions are not uncommon. Incompatibilities, if present, are usually apparent within forty minutes but, for absolute safety, the full one and one-half hour observation period

is necessary. In approximately 4 per cent of tests between bloods of the same group incompatibility is found which is usually due to agglutination unrevealed by the blood grouping tests but occasionally to hemolysis. If the macroscopic evidence of agglutination is at all doubtful—a rare event—a microscopic examination may be carried out. In no case, however, has the microscopic examination in our hands given additional information, but several hemolytic and agglutination reactions were demonstrated in the test tubes macroscopically which were not found upon microscopic examination.

Compatibility determination by means of this technic requires more time and effort than do the procedures in common use. The time element, however, is not greatly in excess of that required for the necessary preliminary examination for syphilis. The factor of time is important only in so far as it concerns the welfare of the patient. It is high time that clinicians concede this point and act accordingly by ceasing their unreasonable demands for speed in the laboratory which precludes the use of safe methods in these preliminary tests. Their reasonable and wise anticipation of the possible or probable necessity for blood transfusion before an emergency occurs will avoid in most instances the unexpected necessity for immediate blood transfusion without sufficient time for safe and accurate laboratory tests. Where provisions of this kind are impossible, temporary substitutes for blood, like saline solution, is in our opinion much better for the patient often times than is blood which has been hastily examined by a fallible method. Too often such examinations are performed by nervous and improperly trained interns and technicians whose incompetence is accentuated appreciably by the unreasonable demands for speed made by the clinician.

Of course it is conceded that the condition of the patient does at times necessitate the immediate administration of blood with acceptance of the risks which this procedure involves. This fact, however, does not justify the disregarding of vital safeguards whenever it can be avoided with greater safety to the patient.

CONCLUSIONS

1. A noteworthy percentage of severe and fatal reactions still attend the transfusion of freshly drawn blood.
2. These reactions are practically all due to factors of incompatibility.
3. The prevalent methods of examination for these factors are not sufficiently accurate to reveal their presence invariably.

4. Lindeman's technic of "careful, accurate and complete hemolysis and agglutinin tests, when the work is skilfully done"⁸ always reveals the presence of these factors when they occur.

5. Lindeman's technic is practical of application and because of this and its incomparable superiority should replace all other methods of compatibility determination now in general use.

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SEVERE INJURIES OF THE FACE AND JAWS*

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LARGELY because of our mechanized adjuncts of living, injuries of the face and jaws are on the increase. The auto "guest-passenger" injury is one outstanding example. Necessity, therefore, has demanded a greater surgical activity. This has in turn, been reflected in the literature of the subject. Among the recent contributions one should mention the work of Blair, Ivy, Kazanjian, McIndoe and Brown.

For two reasons in particular adequate early repair and replacement—an essential objective of the surgeon—may not be given. Under the conditions often encountered in the first instance, namely, early swelling which tends to mask the true nature of the injury, inadequate treatment is avoidable. In the second example, the condition of the patient may be such that the general effort to save his life rightly takes precedence.

EARLY CARE OF THE SOFT TISSUES

Within the first twelve hours with certain exceptions such as large lacerated wounds, markedly contused wounds and deep wounds of the floor of the mouth, the aim of the surgeon should be to affect thorough cleansing of the wound, remove any foreign bodies, remove evidently devitalized tissue and to effect a closure with the objective of getting healing by primary intention and in some instances, when tissue loss is present, to affect a suitable plastic repair. After twelve hours, often it may be wisest to approximate only loosely the soft tissues which allows some provision for drainage or even to allow the wound to heal by secondary intention without any attempt at approximation. For large, severely lacerated wounds or contused wounds, the surgeon often will obtain a better final result if some time is given for the damaged tissue not entirely destroyed to recover its vitality, and for the devitalized tissue to separate. In certain large, lacerated wounds, sometimes for the purpose of retaining position, very loose approximation of the tissues may be a wise procedure.

* From the Department of Surgery, University of Kansas School of Medicine. Read before the American Association for the Surgery of Trauma, June 7-8, 1940.

For the ordinary incised or lacerated wound, cleansing the wound under continuous irrigation is most satisfactory. Any dirt or oil ground into the skin which may produce tattoo marks must be

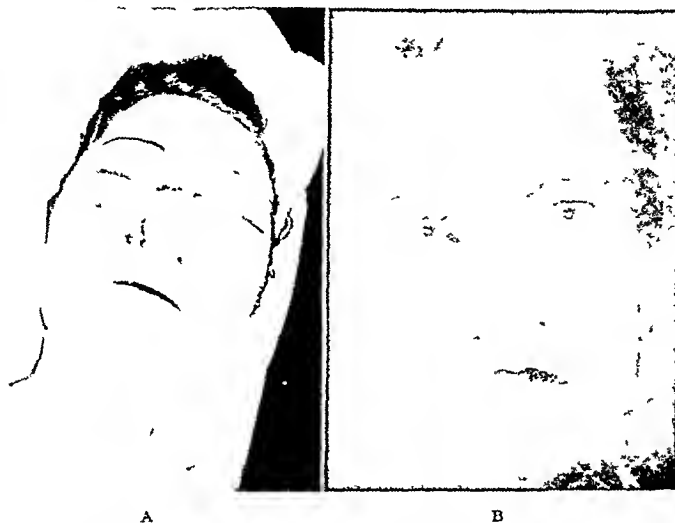


FIG. 1. A, patient who had her nasal bones crushed posteriorly. The anterior maxillary bone was crushed into both ends of her antri on either side. The skin of the nose was badly lacerated. The nasal bones were elevated and both antri were entered through the canine fossa and the wall was pushed forward. The lacerated skin wound was converted into an incised wound and was carefully sutured with fine interrupted sutures. B, the amount of scar present after a year had elapsed.

removed by scrubbing with the proper solvent. Deeply imbedded grains of black powder should be picked out. It is the rule that all foreign bodies should be removed, but deeply imbedded bullets and multiple shot may demand a contrary decision. In general, little débridement should be done about the facial region beyond very slight trimming of shreds, and evidently devitalized tissue and the trimming of skin so that the edges may be brought to each other at perfect right angles. The mandate for careful immediate layer suture applies to "trap door" flaps, scalp flaps, cuts through the ears and eyelids, all narrow double-surfaced flaps such as the border of the eyelid, all through-and-through cuts and tears of the skin, cartilage and mucosa of the nose, large clean cuts in the tongue and mucosa of the cheek. As a rule, it is unwise to suture the floor of the mouth unless adequate inferior drainage is given. The suture of motor nerves of the face is usually not practical. They are too thread-like. When a local area of contusion is present other parts of the wound may be sutured. When a flap has been formed, and one is in doubt of

its blood supply, the flap should be laid in place and held either by a very few tacking sutures or by gentle pressure or both.

All effort to prevent suture marks should be made after the suture



FIG. 2. A, a wound in which approximation due to early swelling when the patient was first seen was not entirely accurate. It will be noted that she also shows some suture marks. B, "Trap door" flap of the forehead. It is to be noted that even with the most careful suturing she still has a slight tendency to elevation.

of facial wounds. As a rule, fine interrupted skin sutures should be placed with fine needles about one-eighth of an inch apart in such a manner that the skin is coapted at an accurate right angle. (Fig. 1A and B.) Every other suture may be removed on the third day and usually all sutures should be removed by the fourth or fifth day. Strips of bandage gauze saturated with "Ace" adherent will give considerable support if applied immediately after the removal of sutures when one doubts the stability of the wound. When deep approximation or tension sutures are advisable, they should be tied over dental rolls. If left in situ longer than four days, a mark will be left where the suture was placed through the skin. (Fig. 2A.) Deep through-and-through sutures tied over a dental roll may be a very efficient method of obliterating a dead space or to hold two parts of a structure from spreading, as for example, the bases of the nose after a severe crushing injury.

"Trap door" flaps with bevelled edges often present a special problem. (Fig. 2B.) Due to underlying scar which tends to contract and the thin edge of the derma which tends to shrink, a humped up pad of skin and subcutaneous tissue surrounded by an unsightly scar is likely to form. Usually, one may affect a repair after a trap door flap is raised by excising the circular scar and the dermal base at right angles. Two small v-shaped excisions are made at either end of the horse-shoe shaped external circumference to limit its length.

The skin edges are now carefully approximated by suture and a pressure sponge dressing is applied for ten days.

Occasionally, after loss of the soft tissue one may save time by



FIG. 3. A, example of immediate switching of an artery flap from the lower to the upper lip. B, photograph taken two weeks after the flap was switched to the upper lip.

immediately switching a skin flap into the defect from some appropriate neighboring area. (Fig. 3A and B.) This may occur particularly after loss of a part of either lip or part of the scalp. When a sufficient amount of the scalp has been lost so that closure cannot be effected, the application of a skin graft to the periosteum is an advisable procedure. At times, a very successful closure of a defect of considerable width with definite tissue loss may be made by approximating sliding advancement flaps. (Fig. 4A and B.)

THE TREATMENT OF HEALED SOFT TISSUE INJURIES

Secondary repair, after healing of the soft tissues is complete, may be advisable whenever a wide or depressed scar may be converted into a hair line scar and the contour defect can be eliminated by approximating the deeper, soft tissues. Secondary repair is also indicated when at the primary repair either the soft tissues were not replaced in their proper position or some distortion has resulted from loss or displacement of the tissues. When suture marks are present following careless primary suture, the surgeon is likely to be more embarrassed because of the suture marks which cannot be removed than by the scar of the primary injury which as a rule can largely be obliterated.

For the repair of soft tissue defects which cannot be repaired by simple excision and resuturing, the reconstructive surgeon has two sources of material: skin grafts and skin flaps.



FIG. 4. A, example of method of closure of a wound by sliding and advancing flaps adjacent to the wound. B, result six months later.



FIG. 5. A, example of a large scar with some ectropion of the lip and corner of the mouth which was excised and resurfaced with a thick skin graft. B, final result.

For the coverage of wide, purely surface aseptic denudation a thick intermediate skin graft is usually preferable (Fig. 5A and B), but when there is some contour defect, a skin flap should be selected as a rule. (Fig. 6A and B.) It is necessary that there be an adequate buccal, labial, mucosal or skin lined sulci if the jaws, lips, tongue and cheeks are to perform their natural function.

For the reconstruction of an intraoral lining defect or an atresia of the nostril, correction as a rule can be given by crosscutting the limiting cicatrix followed by resurfacing of the raw defect with a skin

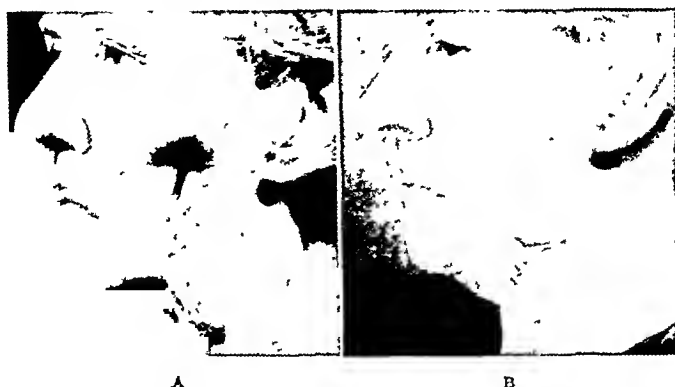


FIG. 6. A, example of a full thickness destruction of the cheek in which some contoural replacement was done by means of a flap of skin and subcutaneous tissue from the neck. B, final result.

graft held in place with a stent. When the intraoral limiting cicatrix is at the posterior angle between the upper and lower jaws, often the use of a flap will give a better functional result than the use of a stent skin graft, as the latter tends to contract to a greater extent than the skin flap. For the building of organs a skin flap has no competition when requiring thickness, for filling a depression in the soft tissues, for building a part requiring two soft pliable epithelial surfaces and some thickness and as a direct covering for bone or cartilage.

TREATMENT OF RECENT FRACTURES OF THE BONES

As a general rule the distortions due to fractures of the bones of the face and jaw should be corrected early. But an exception to this rule is when the cribriform plate is fractured.

RECENT FRACTURES OF THE FRONTAL BONES

When the frontal bone has been crushed inward, the indication if the condition of the patient permits, is elevation of the depressed nose. A crushed in frontal sinus may be pried out by inserting a chisel into the sinus just under the orbital border.

RECENT FRACTURES OF THE NASAL BONES

Fractures of the nasal bones fall roughly into two groups: (1) simple lateral displacement and (2) crushing of the nasal and septal

bones alone and possibly in addition crushing of the nasal, maxillary, lachrymal and ethmoidal bones. After simple lateral displacement or moderate crushing of the nasal bones per se as a rule, it is a fairly simple matter to remold the bones as well as the septal cross-lap laterally or forward to a normal position. Although simple packing forward and upward has been depreciated by Blair as a means of support, it would seem that the method has some value if done thoroughly until sufficient time has elapsed for some cellular infiltration to effect some degree of immobilization. When the crushing force has been such that a varying amount of the nasal, maxillary, lachrymal and ethmoidal compound is involved, one should ascertain by radiographic studies whether or not the cribiform plate of the ethmoids is involved. If so, early replacement is contraindicated. Otherwise early replacement is indicated, and usually can be effected by the nasal route alone; but when the frontal processes with the anterior lachrymal crests of bone are flayed outward into the orbit some instrument, such as a lion jaw forcep which will give mesial compression, should be used. In the severer types of crushing injury of the nasal compound, a simple intranasal pack does not give sufficient support forward and when the frontal process as well as the lachrymal crests or bone has been flayed outward, it is necessary also to prevent lateral spread. The first objectives can be attained by applying a plaster head cast with a heavy wire projecting forward. A very small drill or an awl is then passed through and through the nasal bones. Through these perforations a fine loop of steel wire may be made through the nasal bone to hang over the projecting heavier wire. To prevent lateral spread through a similar perforation a second fine steel wire is passed through and through the frontal processes of the maxillae as near the base of the whole nasal arch as possible. The wires should be passed over some object such as a small rubber tube to prevent cutting of the skin.

RECENT FRACTURES OF THE MAXILLARY COMPOUND

Fractures of the maxilla in so far as treatment is concerned fall into two groups: fractures of the alveolar process and palate and fractures of the superstructure proper. A segment of the alveolar process, which may include the body of the maxillae, may be pushed buccally, labially or lingually. To correct this fracture, one should wire the teeth of the same part of the jaw to the corresponding teeth of the lower jaw after proper fixation by interdental wiring of the upper

unsound segment. Fracture of the transverse process of the maxillae upward and nasalward requires replacement by means of pressure on the floor of the nose. Fracture of the maxillary superstructure includes any part of the loculate mass of bone made up of the maxilla, the lachrymals, the lateral masses and nasal plate of the ethmoids and the pterygoid plates of the sphenoid. These fractures fall into three classic types: (1) The first type of fracture is preceded by a telescoping fracture of the nasal bones. In addition to the nasal bones, the frontal processes of the maxilla are comminuted and crushed and the inner half of the maxillae is fractured through the infraorbital margin about the maxillary malar junction and infraorbital foramen and below the bony vestibule above the alveolar ridge. The direction taken by the fracture lines in the maxilla and ethmoids constitutes a circle drawn around the bony vestibule. The entire block of bone within this circle is thrust posteriorly. In this type of fracture if the cribiform plates are not fractured, the treatment of choice is to enter both antri through the canine fossa so that one may mold the bones forward and upward. Sometimes a gauze pack in each antrum for three weeks will maintain the proper position. When this does not suffice, one may be able to force the bones forward by means of a steel wire passed through the bone at an appropriate point to be looped in a projecting wire in a head cap of plaster. (2) The second type of fracture runs transversely—the inferior part of the superstructure of the maxilla along a more or less transverse plane above the alveolar ridges, and the transverse processes of the maxillae through the lower antral region. (3) The third classic fracture line runs high through the orbits and crosses the frontal processes of the maxilla, the lateral borders of the ethmoids, the pterygoid plates of the sphenoid and temporal processes of the zygoma. As a rule, a complete separation of all of both maxillary bones from the base and the skull occurs.

In many ways, the principle of treatment of the second and third classical types of maxillary fracture is identical. When the body of the mandible is fractured, it has long been known that if the maxillae were not fractured and the teeth were present the maxilla formed an admirable splint for the lower jaw when the lower teeth were fixed to the upper teeth. It has not been so generally recognized that the same principle in an adverse manner may be applied to a fracture of the maxilla. In other words, when the lower jaw is intact, it may be used for a splint and for support to hold the upper jaw intact. In such a case, if the lower teeth are wired to the upper teeth, it neces-

sarily follows—when one holds the lower jaw in its proper position—that the fractured jaw must unite with the teeth in occlusion.

In the past, for the care of fractures of the second and third



FIG. 7. A, head cap made from a felt hat with very heavy elastic bands on the sides to elevate the lower jaw into proper position. The lower teeth should be wired to the upper teeth. B, example of a severe crushing injury of the nose and upper jaw in which the lower jaw was pushed into position and held there by means of a steel wire attached to a heavy projecting wire which was buried in a plaster head cast. A wire was also placed through the nasal bones to hold them together. Although it is not shown in the photograph two dental rolls were placed over the nasal bases to hold them together.

classical types just discussed, many complicated splints have been used. The principles of these splints was to fix the teeth to some type of arch with attached lateral arms which were reversed on themselves after they had been projected forward past the corner of the mouth. The reversed lateral arms were then fixed to a plaster or leather head cap. In other words, the upper jaw is held fixed upward in normal position when the arms of the splints are attached to the skull appliance. It is difficult to adjust splints of this type to the proper level. Thus, if the lower teeth are not placed in occlusion with the upper teeth, when union occurs, one is likely to find that the occlusion has been altered.

Recently we have used a simpler method than the preceding. The method assures proper occlusion of the teeth after healing has occurred. At first, no effort is made to replace the displaced bone. After most of the swelling and edema of the internal nose has disappeared (in about ten to twelve days) when the patient is able to breathe freely through his nose, one may replace the lowered max-

illary fragment. Immediately after the injury, and until free nasal breathing is established, the nose is irrigated with a saline solution to which some vasoconstrictor chemical has been added, every two or three hours. When the air passages through the nose have become clear, the upper teeth are wired to the lower teeth. A skull cap is placed over the skull. A chin cup is placed beneath the chin or body of the mandible. Between the chin cup and skull cap are placed rather strong elastic bands—two on a side. These bands are placed in such a manner that the chin and the body of the mandible are lifted upward. (Fig. 7A.) The principle is to use the mandible as a splint for the maxilla. This method assures proper occlusion and if the elastic bands are tightened sufficiently, the upper jaw is brought into proper position rather quickly.

Occasionally, a child or an adolescent girl will complain of this method as being rather uncomfortable. In several cases of this type a plaster skull cap has been placed about the head. Very fine steel wire was then run through the tip of the mental part of the mandible. To a very stiff wire placed in the head cast so as to project forward, the fine steel wire was attached. (Fig. 7B.) By this means, the upper jaw can be efficiently held at any point one wishes.

FRACTURES IN THE MALAR REGION

The body of the malar bone not uncommonly is driven backward and impacted. When the direction is somewhat downward, the bone may impinge upon the coronoid process and the ramus of the mandible and prevent the mouth from opening. The orbital box is changed in shape. Very commonly the eye globe drops downward and somewhat backward. When one cannot replace the malar bone by inserting a screw elevator through a small opening in the line of fracture, one may obtain replacement by inserting a long, slender bone elevator into a small opening at the upper part of the temporal ridge, thence following the bony wall of the fossa to engage the posterior wall of the bone so that it can be pried forward, or by introducing a sound into the antrum through the canine fossa after which the bone is pried into place.

RECENT FRACTURES OF THE MANDIBLE

A large variety of dental splints have been recommended for use in the management of fractures of the body of the mandible. But when there has been no bony loss and the upper jaw has not been fractured, for the vast majority of fractures of the mandible dental

splints are unnecessary. The principle of using the upper jaw for a splint to hold the lower jaw in position after the lower teeth are wired to the upper teeth is the most simple method. A bilateral fracture of

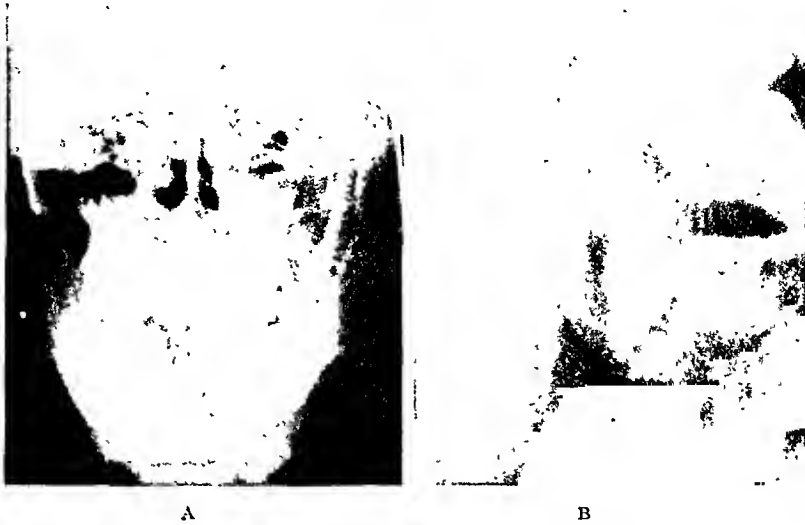


FIG. 8. A, example of a bilateral fracture of the mental region which was held in place by means of a circumferential wire placed about the mandible and up over the maxilla in the subnasal region. B, example of a fracture at the angle of the mandible in which the third molar holds the ramus back in proper position.

the submental region is particularly difficult to hold in place just by simply wiring the lower teeth to the upper teeth because of the spasm of the geniohyoglossus muscles. In such cases one may resort to placing circumferential wires entirely around the body of the mandible after which they may be passed posteriorly to the alveolar ridge, through the palate and across the floor of the nostril just above the maxillary bone and then downward beneath the upper lip. (Fig. 8A.) When the palate is very high, one may have sufficient space to pass a wire above the apex of the incisors through the upper alveolus. By these methods the mental fragment of the mandible can be held firmly upward in apposition with the maxilla.

Fracture at the angle is sometimes difficult to treat properly. The main difficulty in such a fracture arises when the fracture line is posterior to the last occluding molar. When this happens and union occurs, the patient does not open his mouth normally. When the third molar is present, if the ramus fragment impinges against the tooth and is held from being pulled forward by it, the third molar should not be removed but should be left in position for a period of about three weeks for the purpose of maintaining the position of the ramus after the lower teeth are wired to the upper teeth. Usually

after about three weeks the soft tissues about the fracture will have become firm enough to hold the distal fragment in place. (Fig. 8B.) Now with care, one can remove the third molar to prevent its continued action as a foreign body. Usually this is not difficult as it will be found to be considerably loosened. When the third molar is absent or does not hold the ramus downward or backward, the most efficient method is to fix the ramus in its proper position by means of a wire passed through the posterior border of the ramus. The wire is anchored to a plaster skull cap. To expose the posterior edge of the ramus a small incision is made posterior to the angle of the jaw. After a small hole is drilled in the bone, a silver wire is passed through the hole. This wire is looped over a projecting heavier wire extending from the region of the mastoid part of the cast. To unite the ends of the bones by direct wire usually leads to sequestration about the wire which tends to interfere with union.

Because of the close attachment of the internal pterygoid internally and the masseter externally, fracture of the ramus usually shows little or no displacement. Therefore, one usually has no trouble in taking care of fractures across the ramus if one simply wires the lower teeth to the upper teeth. By this method, good position ordinarily will be obtained.

When the condylar neck is fractured, it is usual for the condyle to be pulled forward somewhat by the external pterygoid muscle. As a rule, however, if the lower teeth are wired to the upper teeth when union occurs, the function will be satisfactory. Rarely, one sees a fracture dislocation of the condyle. When the fracture line is rather low adjacent to the ramus, open reduction is satisfactory. When the fracture line is high, possibly one is wiser if the condyle is removed. Reduction is almost impossible to maintain.

The simplest and best method of handling an edentulous fracture of the body of the mandible is to circumscribe the lower jaw and a superimposed splint or lower denture if it has not been lost or broken.

It is not possible to wire the lower teeth to the upper teeth in children as a rule. The deciduous teeth do not withstand traction well. Nor is their shape such that wires ordinarily will stay in place about the neck. Therefore, in fractures of the jaw in children it is sometimes necessary to make use of a dental splint which is cemented to the teeth.

When the tooth necessary for superimposed intermaxillary wiring is absent, a horseshoe shaped half round heavy wire of German silver may be wired to the remaining teeth of either upper or lower jaw or

both. By passing crosswires over the half round wires proper fixation may be obtained.

TREATMENT OF HEALED TRAUMATIC BONY INJURIES OF THE FOREHEAD, NOSE AND UPPER JAW

The healed bony lesions of the forehead, the nose and the face seek correction as a rule because of the contoural defect caused by either displacement or loss of bone. The healed bony lesion of the lower jaw region may show either a contoural defect, a loss of continuity or a malocclusion due to malunion.

When a healed depression of the forehead is symptomless, in my experience as a general rule the best correction is given when superimposed skin flaps are turned back and a properly fitted cartilaginous inlay graft is inserted. The same statement applies to the rebuilding of the supraorbital ridge. McIndoe, however, is rather partisan to bone. He used the inner cortex of the ilium for forehead depressions and the rim of the ilium to build out the supraorbital ridge. All evidence of infection should have disappeared at least three months previously.

FRACTURE DISPLACEMENTS OF THE NASAL BONES

The objective in repairing healed nasal bone fracture displacements is to place the nasal bony arch in the midline, to straighten the cartilaginous arch and to provide a free airway. This should be done as soon as possible.

For healed lateral nasal displacements and curvatures of the nasal arch and septum the best results are obtained when the nasal bones are freed from the maxillary processes and, if necessary, the nasal septum is treated by judicious cartilaginous section or submucous resection or freeing of the septum at the nasal spine. When one side of the nasal arch is too long, it may be well to remove a wedge of bone from the base of the longer side. When the nose tends to return to its former position after mobilization, sometimes a through-and-through steel wire looped over an opposite tooth and over a piece of rubber tube or dental roll on the side to which the deviation tends will prove efficient. At other times, it may be wiser to apply definite lateral immobilization by means of a head cast from which projects a wire which lies along the lateral side of the nose. This is worn until union is sufficient—during the second and third weeks after immobilization.

PADGETT—INJURIES OF FACE AND JAWS

For the correction of healed crushing fractures of the nose as a rule the mandate is elevation of the bridge or bridge and tip by the insertion of an implant of cartilage. If the tip is depressed, a right

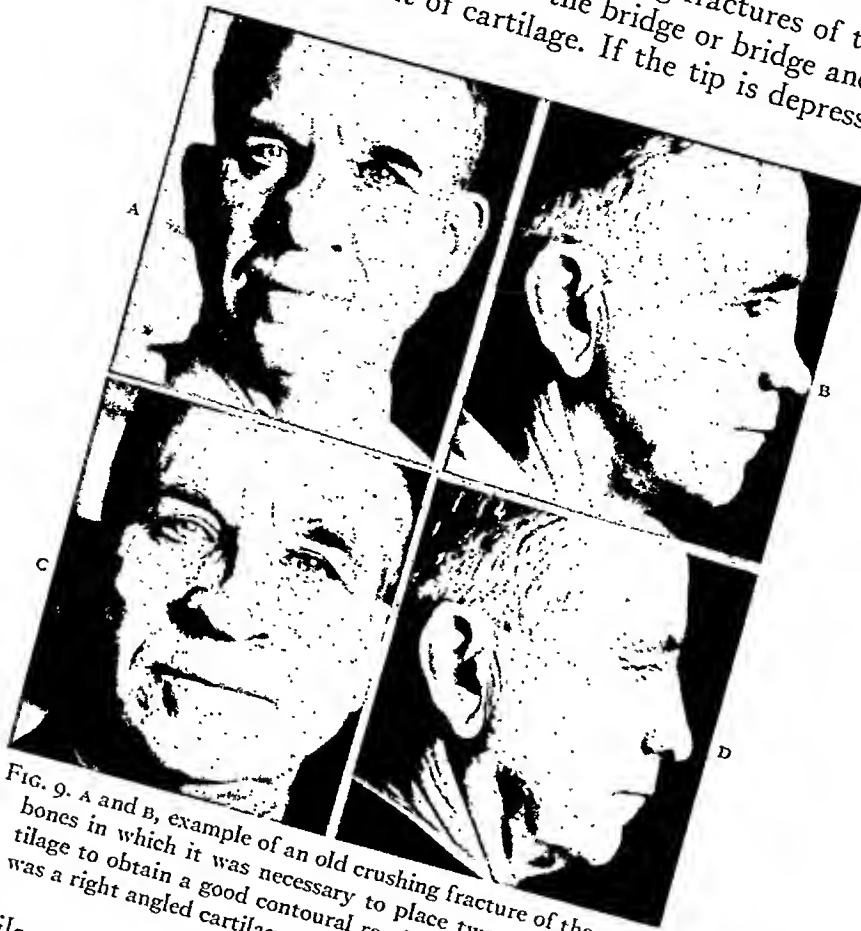


FIG. 9. A and B, example of an old crushing fracture of the nasal bones in which it was necessary to place two pieces of cartilage to obtain a good contour result. The upper cartilage was a right angled cartilage. C. and D, final result.

angled cartilage is indicated; if not, a dorsal straight implant is sufficient. Not uncommonly, two superimposed cartilages are necessary. (Fig. 9A and B.) When the frontal processes and the lachrymal crests have been splayed outward over the maxilla and into the orbit, the nasal arch may require cross-cutting at the base followed by medial replacement and the splayed out bone projecting into the orbit should be chiseled or rongeured away. This should be done before the cartilage is transplanted. Sometimes, it is wise to transplant the cartilage at separate sittings if a superimposed piece is necessary. This will depend upon the degree of difficulty in mobilizing the soft tissues. The septal deformity is corrected in a manner similar to that just discussed under healed lateral nasal displacements.

Whether or not one does a cartilage transplant in combination with another procedure on the bones or the septum will depend upon whether or not the combined operation is likely to result in contamination of the bed in which the cartilage has to lie.

Usually in healed malar maxillary distortions in addition to displacement of the malar bone inward, downward and backward, there is evidence of serious displacement and comminution of the maxilla which usually results in destruction or depression of the infraorbital plate causing downward displacement of the globe of the eye. The first decision to make is whether treatment is to begin with an effort at disimpaction and elevation of the malar maxillary displacement or whether treatment by camouflage is preferable. As a rule, some camouflage therapy will be necessary even if replacement is done because complete replacement may not be possible. For disimpaction a double approach is as a rule necessary; (1) from beneath the upper lip across the anterior maxillary wall and (2) through an incision in the upper temporal region so that a chisel may be passed posterior to the temporal muscle to a point behind the malar bone. These approaches also allow one to pry the bone forward. To hold the bone forward and upward, it will be necessary to pass a fine steel wire through the bone to be looped over a heavy projecting wire laid in a plaster cast head gear. The best camouflage treatment as a rule is obtained by filling out the contoural defect of the cheek with implants of cartilage. (Fig. 10A and B.) When the infraorbital plate has been lowered, implants of cartilage should be inserted to elevate the infraorbital floor. When an enophthalmus is present, sometimes some improvement can be given by inserting cartilage posterior to the globe and external to the muscles controlling the globe. To do this, the approach devised by Killian is necessary. When the malar bone is down far posteriorly and medially and impinging upon the coronoid process and the ramus, it may be advisable to remove the bone.

The well known "dish-face" deformity caused by a healed nasal ethmoidal maxillary fracture displacement is difficult to correct. Satisfactory elevation of the impaction is hardly possible but there are several procedures of the camouflage nature which may give quite remarkable improvement both in appearance and in function. It is stated by McIndoe that sometimes before six weeks have passed, this impaction may be advanced as much as one-half inch by means of pulley traction. Usually a submucous resection will be necessary. Often the tear ducts are blocked. By removal of the intervening bony

partition and an appropriate plastic operation the tear sac may be drained into the nose. The splayed frontal process of the maxilla and the lachrymal ridge may be chiselled and rongeured away. The bony



FIG. 10. A, depression defect in the left cheek and maxillary region in which the depression was filled out by a cartilage transplant after two flaps had been laid back. B, final result.

arch of the nose can be built up by cartilage implantation. The depressions about the alar bases and over the antrum if present may be filled out by judicious insertion of cartilaginous implants of the appropriate size and shape.

LOSS OF BONE

When there has been loss of maxillary bone if the loss is only of the alveolus or the lower part of the super structure is not large, a dental prosthesis without any reconstruction of the soft tissues usually is sufficient. But when the loss of bone of the superstructure is greater than one-half, it will often be necessary to add additional epithelial lining either by means of a skin graft or a skin flap so that not only adequate masticating power may be provided but the contour of the face may be corrected by prosthesis.

BONY LOSS OF THE MANDIBLE

Two types of bony loss of the mandible are seen: parallel loss and rectangular loss (loss of continuity). Parallel loss of the mandible along the lower border causes a contoural defect which may be corrected by the implantation of cartilage. When the loss is intraoral, it should be compensated for by prosthesis.

Loss of continuity of the mandible is always associated with considerable disfunction because the muscles of mastication tend to

lose their normal co-ordinated activity. Scar tissue adds to the distortion. When the loss of continuity is not greater than a few centimeters, the method of Delengeniereor Kazanjian of placing multiple



FIG. 11. A, roentgenogram of a defect in the body of the mandible due to a gunshot wound. The ramus is being held back by a wire placed through it and inserted into a projecting wire at the posterior part of a head cast. B, x-ray one year after a bone graft was inserted.

small pieces of bone and periosteum across the defect may be quite applicable. During the last War of thirty-eight patients operated upon by this method in the United States Army, twenty-seven (71 per cent) were successful.

Defects in the lower jaw region complicated by a fairly large loss in bony continuity have been repaired in four different ways: (1) by free bone graft; (2) by bone transplanted in a pedicled flap from a distance; (3) by sliding a section of bone from a neighboring fragment without freeing it from its soft tissue attachments; and (4) substitution of prosthesis for loss of about one-half of the mandible.

A free bone graft is most applicable when the surrounding soft tissues are sufficient or easily transferred and when the defect is a long one of the body and a part of the ramus of the mandible. The graft may be taken from a rib (Fig. 11A and B) or the crest of the ilium. The crest of the ilium is preferable when the angle is absent.

Often time can be saved when it is necessary to add soft tissue lining and covering as well as structural support if all three are transplanted together. A fairly accessible area from which to obtain the bone and necessary soft tissue is the clavicular area. A split half of a longitudinal section of the clavicle is buried in a skin flap doubled upon itself.

When the body of the mandible is long on one side and there is also a soft tissue defect, and especially if the loss is in the mental region, an oblique, longitudinal segment of the lower part of the long body fragment with soft tissue attachment may be slipped across to bridge the bony defect. Later, after union is obtained, the contour of the face may be improved if the soft tissues are rearranged and possibly replaced to nearly their former position.

If the whole region of the position of the half mandible that has been lost is relined with a skin flap, it is possible to hold the intact half of the jaw in fair position and to bolster out the contour of the cheek on the defective side by building an intraoral prosthesis in lieu of the loss of the mandible.

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DISCUSSION OF PAPERS OF DR. CAMERON AND DR. PADGETT

FENWICK BEEKMAN (New York City): I feel that I am incompetent to discuss this admirable paper of Dr. Padgett. As a general surgeon, I am not trained in maxillary or oral surgery; however, we see in New York City, especially in our public hospitals, a great many late results of trauma. In a large city like New York we do not get the fresh accidents that the smaller cities throughout the Union do, as most of our patients are first treated in the country and then they are sent to us.

I picked out of my collection of lantern slides four or five illustrations which I think will demonstrate some of the things that Dr. Padgett has spoken about today.

The first is that of a boy, about seven years of age, who came into the hospital after having been in an automobile accident on Long Island. He was taken to a local hospital and there the surgeon débrided his entire lower lip and chin, leaving a large elliptical wound from which he drooled a large amount of saliva the entire time.

This is the mistake that is made so often, instead of tacking together whatever tissue there is, even if it be contused and lacerated, so that we would have something to work on, it was excised completely, leaving very little tissue to work with; however, we were able to undermine and reconstruct a lower lip.

I meant later on to fill in the chin with a flap from his chest or from his arm, but the parents, who were very ignorant people, insisted upon removing him from the hospital and I have never seen him since then.

My second case was not a case of trauma, but it represents very well the need of using pedicle flaps in restoring a face. This was a child in Bellevue Hospital, who had a noma of the face. It was symmetrical. A year later, infection having been overcome, she was handed over to me so that I could do what I could with her.

Not only had the soft tissues of the face necrosed but also a large amount of the lower jaw. She could retain no saliva in her mouth. It was dripping out continuously. I raised a flap from the chest on the right side and brought it up to form a lower lip. I then closed the nostrils with the tissues that were present and brought another pedicle flap from the right arm and made an upper lip. Then, to fill out the nose, I raised a pedicle flap from her axillary region, fastened it to her wrist and brought it up to build the nose.

Having gotten the flaps in position, they were very large and ungainly, so I commenced to mold them into position.

I did not bring the slides showing the intermediate parts of my procedure, but I have the almost final result which we will now show you.

This was the girl taken a year ago. She is now sixteen years of age and since these pictures were taken, I have taken some fat out from beneath her chin. Last year I attempted to put cartilage in the nose but, unfortunately, every time I operate on her now, she develops an erysipelas, as she did in this case, and the cartilage sloughs out; however, she is better-looking now than she was in the first pictures.

I think we owe a debt to Dr. Padgett for bringing these things up because I believe general surgeons should know something of plastic surgery.

HARRY E. MOCK (Chicago, Ill.): Dr. Cameron's paper is exceedingly timely and since he paid quite a compliment to St. Luke's Hospital in Chicago, and Dr. Hirsch, I think some one of us should acknowledge the compliment and bear out his statements.

In 1924, I think, occurred the last death we had from blood transfusion, by one of our best surgeons on a very important patient, and, following that, Dr. Hirsch developed the technic which you outlined. As one of the clinicians there, time and again I have tried to rush Dr. Hirsch on skipping the office hour, or something of the kind, but it is utterly impossible to get him to vary from the one hour and a half, and we have all come to agree that it is right and proper. Seldom does the patient require the blood transfusion

in such an emergency that we cannot give that hour and a half; and, when it is necessary, our salt and glucose are used until the time is up and we can transfer to a true blood transfusion.

I think that out in the country—I see a number of blood transfusions—only once have I seen a fatality, but I marvel at what they get away with sometimes, the short period of grouping the blood or of grouping and compatibility, and I think that this is one of the greatest contributions that has come before us, and it should be stressed—the care with which the blood should be chosen for these transfusions I also want to compliment the essayist on that last paper, too, for it was excellent.

ANGUS L. CAMERON (closing): I simply want to thank the discussor, Dr. Mock, for his very kind remarks.

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